

BENSHAW
ADVANCED CONTROLS & DRIVES

REDISTART DIGITAL
RDB6 SERIES
INSTRUCTION MANUAL

The Leader In
Solid State Motor Control
Technology

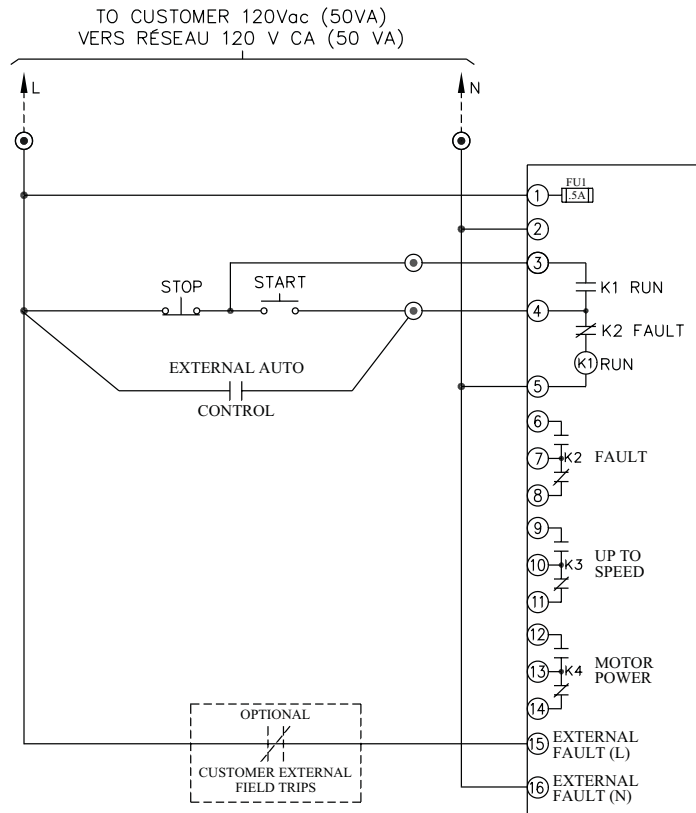
QUICK START GUIDE

Quick Start

General

This quickstart guide provides the information necessary for the operator to set the starter for basic operation. This manual should be read in its entirety before the starter is put into service.

- Connect the incoming power connections to terminals L1, L2 and L3.
- Connect the motor leads to T1, T2, and T3.
- Connect the control wiring to TB1 on the control card, as shown in the following diagram. **USE ONLY THE START/STOP BUTTONS OR THE EXTERNAL AUTO CONTROL.**



- Turn on the power to the starter. The display should show the software release number and then $r-dH$. If not, refer to the starter diagnostics beginning on page 38.
- See the programming chapter beginning on page 20 for a complete description of programming procedures and parameter descriptions. The important parameters to program are P1, P2, P3, P4, and P6.
- Provide a short Start/Stop sequence to the starter to check motor rotation. If the motor rotates backwards, swap any two power leads.
- Give a Start command and allow the motor to accelerate to speed.
- If the motor doesn't begin accelerating immediately, increase parameter P4. If it takes off too quickly, decrease P4.
- If the motor takes too long to accelerate, decrease P6. If the motor accelerates too quickly, increase P6.

1. INTRODUCTION	1
1.1 How To Use This Manual	1
1.2 Product Description	2
2. TECHNICAL INFORMATION	4
2.1 Physical Specifications.	4
2.2 Control Power	4
2.3 Storage.	5
2.4 EU Declaration of Conformity	6
2.5 Solid State Overload	7
2.6 Chassis Rating	8
2.7 Standard and Heavy Duty Horsepower Ratings	8
2.8 Circuit Card Layout	10
2.9 Spare Parts	11
3. INSTALLATION.	12
3.1 Site Preparation.	12
3.2 EMC Installation guidelines	12
3.3 Installation Procedures	13
3.4 CT Ratio Scaling Switches.	16
3.5 Hardware Deceleration Control	17
3.6 Variable Voltage or Current Input	18
3.7 Door Mounted Display	18
4. OPERATING PARAMETERS	20
4.1 General Operating Parameter Information	20
4.2 P1 - Motor Full Load Amps	21
4.3 P2 - Overload Multiplier	21
4.4 P3 - Motor Thermal Overload	22
4.5 P4 - Initial Motor Starting Current	22
4.6 P5 - Maximum Motor Starting Current	23
4.7 P6 - Motor Ramp Time	23
4.8 P7 - Motor Stall Time	24
4.9 P8 - Deceleration Level 1	24
4.10 P9 - Deceleration Level 2.	25
4.11 P10 - Deceleration Time	25
4.12 P11 - Overcurrent Trip Level	26
4.13 P12 - Overcurrent Trip Time.	26

TABLE OF CONTENTS

4.14 P13 - Undercurrent Trip Level	26
4.15 P14 - Undercurrent Trip Time	27
4.16 P15 - Line Phase Sensitivity	27
4.17 P16 - Motor Current Imbalance	28
4.18 P17 - Current Transformer Ratio	28
4.19 P18 - Meter Mode	28
4.20 P19 - Meter Dwell Time	29
4.21 P20 - Passcode	29
4.22 P21 - 500% Current Kick Time.	29
4.23 P22 - Starter Mode	30
5. OPERATING PROCEDURES	31
5.1 Pushbutton Functions	31
5.2 Starting The Motor.	32
5.3 Operating Messages	35
5.4 Fault Codes	36
5.5 Preventative Maintenance.	37
5.6 Starter Diagnostics	38
5.7 Default Settings.	41
6. DISPLAY TEMPLATE	43
6.1 Door Mounted Display Template	43
7. INSIDE DELTA OPTION	44

General Information

The RediStart Digital motor starter operations manual provides the following information:

- Specifications.
- Installation site requirements.
- Installation.
- Programming.
- Operation.
- Diagnostics.

How to Use this Manual

The operations manual is divided into five sections:

- Introduction.
- Technical information.
- Installation procedures.
- Operating parameters.
- Operating procedures.

Each section contains subsections with detailed information on the relative topics. The subsections contain general information, details and any necessary precautions about the individual topics. The specific information contained in the subsections can be found quickly and easily by reviewing the subject headings on the left margin.

**Operations Manual
On-Line**

The operations manual can be found on-line at:
<http://www.benshaw.com>

The manual is available in Adobe Acrobat portable document format (pdf). Adobe and Acrobat are trademarks of Adobe Systems Incorporated.

Parameter Chart

There is a parameter chart on page 41 of the manual. This parameter chart lists each operating parameter with its name, values and defaults. A space is provided on the chart for the user's current parameter settings. When the operating parameters are set for the current application, they should be listed on the chart for future reference.

1. INTRODUCTION

1.2

Product Description

General Information

The RediStart Digital motor starter is a microprocessor-controlled starter for single or three-phase induction motors. The starter can be custom designed for specific applications.

The starter offers:

- Solid state design.
- Current limited reduced voltage starting.
- Closed-loop motor current control.
- Programmable motor protection.
- Programmable operating parameters.
- Programmable metering.

Available in NEMA (National Electrical Manufacturers Association) specified frame sizes, the starter may be used in numerous industrial applications. Each starter can operate within applied voltage and frequency values of 100VAC to 600VAC (optional 1000VAC) and 23 to 75Hz. This feature enables the RDB6 to be installed in a wide range of sites and countries.

The starter can be programmed for any motor FLA and all of the common motor service factors. It enables operators to control both motor acceleration and deceleration. It also protects the motor and its load from damage that could be caused by incorrect phase order wiring.

The starter continually monitors the amount of current being delivered to the motor. This protects the motor from overheating or drawing excess current. The starter will automatically stop the motor if the line-to-line current is not within acceptable ranges or if the current is lost in a line.

Features

The enhanced engineering features of the starter include:

- Multiple frame sizes.
- Universal voltage operation.
- Universal frequency operation.
- Programmable motor overload multiplier.
- Controlled acceleration and deceleration.
- Phase rotation protection.
- Regulated current control.
- Electronic motor thermal overload protection.
- Electronic over/under current protection.
- Single phase protection.
- Line-to-line current imbalance protection.
- Stalled motor protection.
- Programmable metering.
- Passcode protection.

Optional Features

Depending on the system configuration and customer specifications, the starter can be customized to include:

- Door mounted keypad/display.
- Over and under voltage relays.
- Voltage unbalance sensors.
- Over and under current relays.
- Current unbalance sensors that also detect single-phase fault conditions.
- Ground fault relays.
- Motor protection systems.
- Display indicator lights mounted on the cabinet.
- External overload relays.
- Meters or metering packages.
- Circuit disconnecting devices.

Components

The major components of the starter are:

- Customized line and load lugs or pads.
- Six (three-phase) or four (single-phase) SCRs with SIOV protection.
- Printed circuit assembly control card.
- Terminals for two-wire or three-wire 120VAC control.
- Current feedback transformers.
- An isolated heat sink with dual-SCR flat packs or a live heat sink with puck-shaped SCRs.

LED Display

A three character, alphanumeric LED display located on the control card (or on the optional door mounted display) displays:

- Status information.
- Operating parameters.
- Fault codes.
- Thermal Overload Content.
- Motor current.
- Motor current imbalance percentage.

Control Relays

The starter has four control relays:

- Start/Stop input relay.
- Fault output relay.
- UTS (up to speed) output relay.
- Motor power output relay.

2. TECHNICAL INFORMATION

2.1

Physical Specifications

General Information

The physical specifications of the starter vary depending upon its configuration. The configuration is determined by the applicable motor current and its specific application requirements.

Heat sink

The starter uses one of two distinct types of heat sinks:

- An isolated heat sink with dual SCR flat packs on RDB-27 to RDB-96 models.
- A live heat sink with puck-style SCRs on RDB-124 to RDB-720 models.

Dimensions

The chassis sizes are given in the following chart;

Catalog #	Chassis Size (H" x W" x D")
RDB-27	14 x 10 x 6
RDB-40	14 x 10 x 6
RDB-52	16 x 10 x 7
RDB-65	16 x 10 x 7
RDB-77	16 x 10 x 7
RDB-96	16 x 10 x 7
RDB-124	16 x 12 x 9
RDB-156	16 x 12 x 9
RDB-180	18 x 12 x 10
RDB-240	20 x 14 x 10
RDB-302	20 x 14 x 10
RDB-361	20 x 14 x 10
RDB-477	35 x 16 x 12
RDB-590	35 x 16 x 12
RDB-720	35 x 16 x 12

2.2

Control Power

Chassis VA Requirements

The power requirements for each starter size is given in the table:

Catalog #	Transformer Requirements (VA)
RDB-27	50
RDB-40	50
RDB-52	80
RDB-65	80
RDB-77	80
RDB-96	80
RDB-124	70
RDB-156	70
RDB-180	70
RDB-240	80
RDB-302	125
RDB-361	125
RDB-477	275
RDB-590	275
RDB-720	275

2. TECHNICAL INFORMATION

Total VA Requirements

The power requirements of the complete starter package also depend on the other devices in the package. The VA requirements of some common devices are:

- 4" fan - 23VA
- 6" fan - 42VA
- Pilot Light - 3VA
- Control Relay - 5VA

The VA requirements of the control card and any other devices in the package must be added together. Multiply the total by 1.2 to get the minimum transformer size required.

Control Terminals

The TB1 terminal block has the following control terminal configuration:

- TB1-1 Control power - Line.
- TB1-2 Control power - Neutral.
- TB1-3 Run relay holding contact.
- TB1-4 Run relay line.
- TB1-5 Run relay neutral.
- TB1-6 Fault contact N.O. (not faulted).
- TB1-7 Fault contact common.
- TB1-8 Fault contact N.C. (not faulted).
- TB1-9 Up-to-speed contact N.O. (not at full speed).
- TB1-10 Up-to-speed contact common.
- TB1-11 Up-to-speed contact N.C. (not at full speed).
- TB1-12 Motor power N.O. (When motor is stopped).
- TB1-13 Motor power common.
- TB1-14 Motor power N.C. (When motor is stopped).
- TB1-15 External trip input line (120VAC applied or trip occurs).
- TB1-16 External trip input neutral.

- TB2-1 Internal power for potentiometer voltage control.
- TB2-2 Voltage or current control signal input.
- TB2-3 Voltage or current control signal common.

Output Contact Ratings

Fault Relay:

2A resistive, 1A inductive, 125VAC

Up-to-Speed Relay & Motor Power Relay:

16A resistive, 8A inductive, 250VAC

2.3

Storage

General

If the starter is to be stored for a significant period of time before being installed, certain storage environmental conditions must be maintained.

NOTE: The suggested maximum storage length is two years.

Environmental Conditions

To protect the starter during the storage period the following environmental conditions must be maintained:

- -40 degrees Fahrenheit to 158 degrees Fahrenheit (-40 degrees Centigrade to 70 degrees Centigrade).
- 20% to 95% relative humidity (non-condensing).

The maximum acceptable temperature and humidity changes in 30 minutes are:

- 10.8 degrees Fahrenheit (6 degrees Centigrade).
- 10% humidity.

2. TECHNICAL INFORMATION

2.4

EU Declaration of Conformity

According to the EMC – Directive 89/336/EEC as Amended by 92/31/EEC and 93/68/EEC

Product Category: Motor Controller
Product Type: Reduced Voltage Solid State Motor Controller
Model Numbers: RDB6
Manufactures Name: Benshaw, Inc.
Manufacture's Address: 1659 East Sutter Road
Glenshaw, PA USA
15116

The before mentioned products comply with the following EU directives and Standards:

Safety: UL 508 Standard for Industrial Control Equipment covering devices for starting, stopping, regulating, controlling, or protecting electric motors with ratings of 1500 volts or less.

EMC: EN 50081-2 Emissions Radiated/Conducted
EN 55011/05.98+A1:1999

EN 50082-2 Immunity/Susceptibility which includes:
EN 61000-4-2 Electrostatic Discharge
EN 61000-4-3 Radiated RF
EN 61000-4-4 Electrical Fast Transient/Burst
EN 61000-4-6 Injected Currents

The technical files and other documentation are on file at Benshaw, Inc. and controlled by the Product Engineering Group. Benshaw, Inc. has internal production control systems that ensures compliance between the manufactured products and the technical documentation.

The product is CE marked in April 2000.

Brian Seman
Quality Control Manager

Harry Hagerty
Advanced Controls and Drives Manager

Charles E. Cook
Product Development Manager

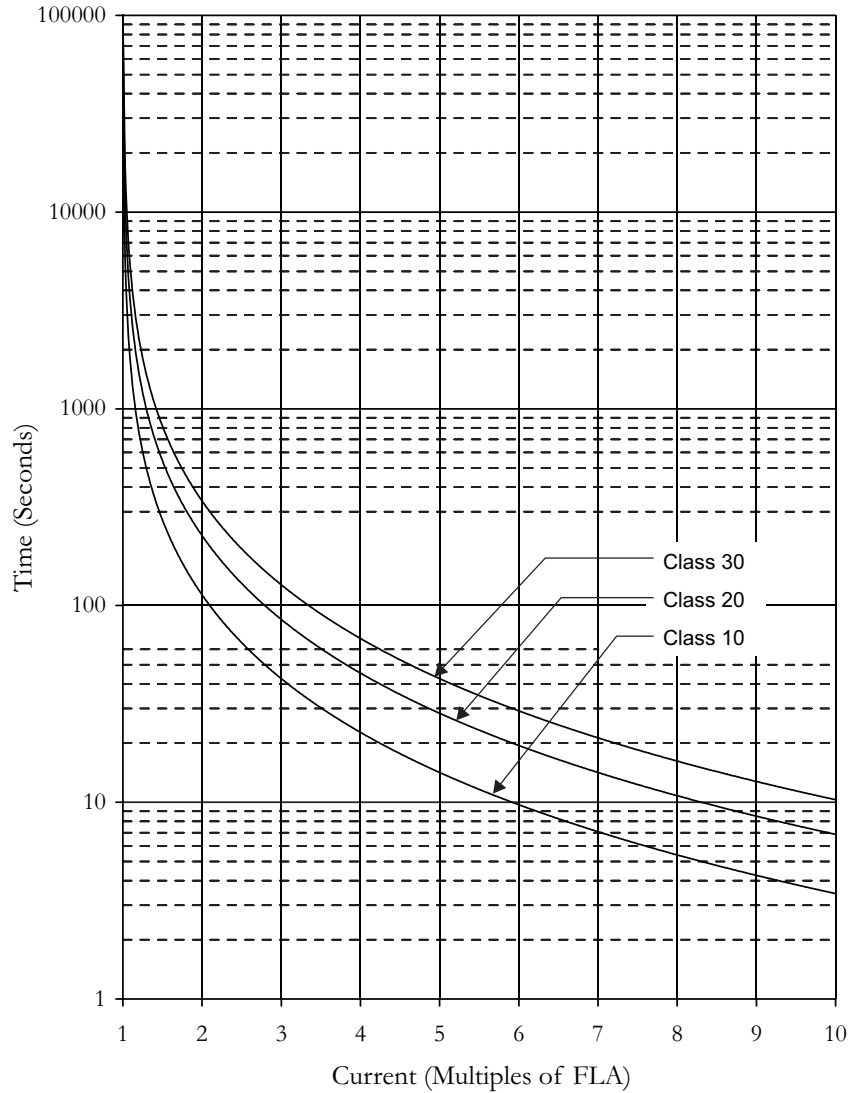
2. TECHNICAL INFORMATION

2.5

Solid State Overload

General

The starter incorporates an electronic overload which allows the user to select a class 10, 20, or 30 overload. The following curves serve to define the different overload classes.



The thermal overload trip time will be lowered once the motor has been operated. See page 33 for a complete description of the overload operation.

2. TECHNICAL INFORMATION

2.6

Chassis Rating

Catalog Number	Nominal Current (A)	115% Current Rating (A)	Unit Withstand Rating (KA)	Fuse/Circuit Breaker Protected Rating		
				Fuse Class /Circuit Breaker Cat.No.	Max Fuse Current Rating/Trip Plug, A	Short Circuit Rating, KA
RDB-27	27	31	5	Class J/T		5
RDB-40	40	46	5	Class J/T		5
RDB-52	52	59.8	5	Class J/T		5
RDB-65	65	75	5	Class J/T		5
RDB-77	77	89	5	Class J/T		5
RDB-96	96	110	10	Class J/T		10
RDB-124	124	179	10	Class J/T		10
RDB-156	156	143	10	Class J/T		10
RDB-180	180	207	10	Class J/T		10
RDB-240	240	276	10	Class J/T		10
RDB-302	302	347	18	Class J/T		18
RDB-361	361	415	18	Class J/T		18
RDB-477	477	549	30	Class J/T		30
RDB-590	590	679	30	Class J/T		30
RDB-720	720	828	30	Class J/T		30

2.7

Standard and Heavy Duty Horsepower Ratings

General

There are 15 different RDB chassis sizes. Each frame size has two different horsepower ratings depending on the application.

Standard Duty Rating

The standard duty horsepower rating is for normal motor starting. The standard duty rating is a motor current that is 350% (3.5 times) of the full-load current for 30 seconds. The standard duty rating table lists the maximum size of motor that can be started by each RDB unit.

Catalog #	Nominal Current (A)	Horsepower Rating (hp for listed VAC)			
		208	220-240	440-480	600
RDB-27	27	7.5	10	20	25
RDB-40	40	10	15	30	40
RDB-52	52	15	20	40	50
RDB-65	65	20	25	50	60
RDB-77	77	25	30	60	75
RDB-96	96	30	40	75	100
RDB-124	124	40	50	100	125
RDB-156	156	50	60	125	150
RDB-180	180	60	75	150	200
RDB-240	240	75	100	200	250
RDB-302	302	100	125	250	300
RDB-361	361	125	150	300	400
RDB-477	477	150	200	400	500
RDB-590	590	200	250	500	600
RDB-720	720	250	300	600	700

2. TECHNICAL INFORMATION

Heavy Duty Rating

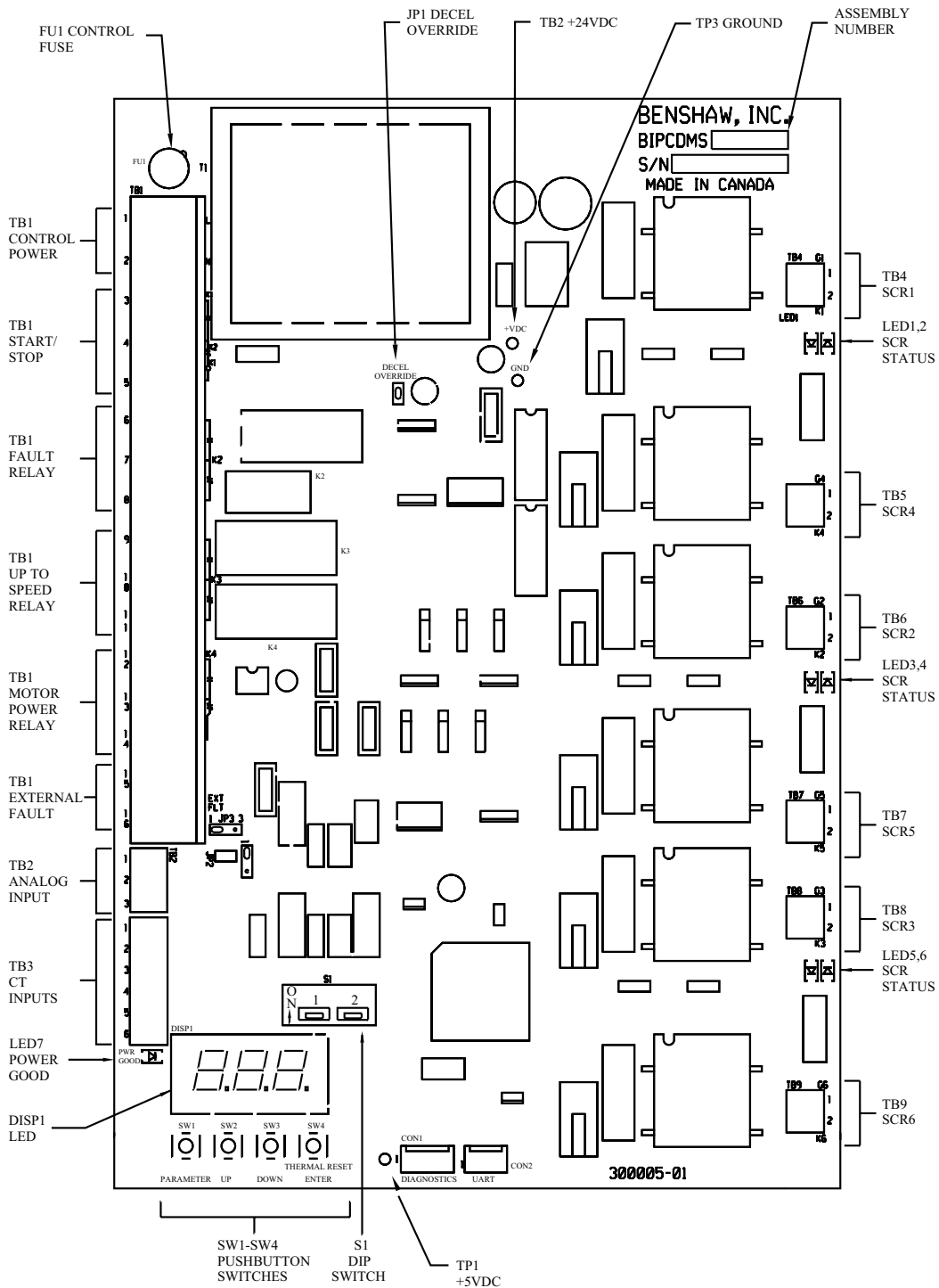
The heavy duty rating is for heavy duty motor starting. The heavy duty rating is a starting current that is up to 500% (5 times) of the full-load current for 30 seconds. The heavy duty rating table lists the maximum size of motor that can be started by each RDB unit.

Catalog #	Nominal Current (A)	Horsepower Rating (hp for listed VAC)			
		208	220-240	440-480	600
RDB-27	27	7.5	10	20	25
RDB-40	40	10	10	25	30
RDB-52	52	10	15	30	40
RDB-65	65	10	15	30	40
RDB-77	77	10	15	30	40
RDB-96	96	25	30	60	75
RDB-124	124	30	40	75	100
RDB-156	156	30	40	75	100
RDB-180	180	60	75	150	200
RDB-240	240	75	100	200	250
RDB-302	302	75	100	200	250
RDB-361	361	75	100	200	250
RDB-477	477	100	125	250	300
RDB-590	590	150	200	400	500
RDB-720	720	200	250	500	600

2. TECHNICAL INFORMATION

2.8

Circuit Card Layout



2. TECHNICAL INFORMATION

2.9

Spare Parts

General

The following lists the spare parts for the different starter sizes:

Part Number	Description	Used On	Quantity
BIPCDMS	control card	all	1
BI-M-FU1	control card fuse	all	1
BISCR5012X	50 amp dual flat pack SCR	RDB-27, RDB-40	3
BISCR10012X	100 amp dual flat pack SCR	RDB-52, RDB-65, RDB-77	3
BISCR13212X	132 amp dual flat pack SCR	RDB-96	3
BISCR?????	218 amp puck style SCR	RDB-124, RDB-156	6
BISCR6601218	660 amp puck style SCR	RDB-180, RDB-240 RDB-302, RDB-361	6
BISCR15001850	1500 amp puck style SCR	RDB-477, RDB-590, RDB-720	6
BICT2881M	288:1 ratio current transformer	RDB-27, RDB-40 RDB-52, RDB-65	3
BICT8641M	864:1 ratio current transformer	RDB-77, RDB-96 RDB-124, RDB-156	3
BICT26401M	2640:1 ratio current transformer	RDB-180, RDB-240 RDB-302, RDB-361	3
BICT57601M	5760:1 ratio current transformer	RDB-477, RDB-590, RDB-720	3
RSC-18	30A AC-1 rated bypass contactor	RDB-27	1
RSC-32	45A AC-1 rated bypass contactor	RDB-40	1
RSC-50	70A AC-1 rated bypass contactor	RDB-52, RDB-65	1
RSC-65	80A AC-1 rated bypass contactor	RDB-77	1
RSC-85	100A AC-1 rated bypass contactor	RDB-96	1
RSC-100	150A AC-1 rated bypass contactor	RDB-124	1
RSC-125	160A AC-1 rated bypass contactor	RDB-156	1
RSC-150	210A AC-1 rated bypass contactor	RDB-180	1
RSC-220	275A AC-1 rated bypass contactor	RDB-240	1
RSC-300	350A AC-1 rated bypass contactor	RDB-302	1
RSC-400	450A AC-1 rated bypass contactor	RDB-361	1
RSC-600	660A AC-1 rated bypass contactor	RDB-477, RDB-590	1
RSC-800	840A AC-1 rated bypass contactor	RDB-720	1
BIOT	Over temperature Switch	all	1

3. INSTALLATION

3.1	Site Preparation
General Information	Before the starter can be installed, the installation site must be prepared. The customer is responsible for: <ul style="list-style-type: none">• Providing the correct power source.• Selecting the control mechanism.• Obtaining the connection cables.• Ensuring the installation site meets all environmental specifications for the enclosure NEMA rating.• Installing the motor.
Connection Cables	The connection cables for the starter must have the correct current NEC/CSA rating for the unit being installed. Depending upon the model, the connection cables can range from a single #14 AWG conductor to four 750 MCM cables.
Site Requirements	The installation site must adhere to the applicable starter NEMA/CEMA rating. For optimal performance, the installation site must meet the following specifications: <ul style="list-style-type: none">• Temperature: 32 degrees Fahrenheit to 104 degrees Fahrenheit (0 degrees Centigrade to 40 degrees Centigrade).• Humidity: 20% to 95% non-condensing.• Airways: Clearances are provided around all heat sinks.• Altitude: Less than 3300 feet (1000 meters) above sea level. <p>NOTE: At altitudes greater than 3300 feet (1000 meters) above sea level, the starter size must be derated 1% for every 330 feet (100 meters) above this level.</p>
Mounting	The starter must be mounted so the heat sink fins are vertically oriented in an area that does not experience excessive shock or vibration. All models require airway passages around the heat sink. During normal operation the heat sink may reach 194 degrees Fahrenheit (90 degrees Centigrade). Do not install the starter in direct contact with any materials that cannot withstand these temperatures.
3.2	EMC Installation guidelines
General	In order to help our customers comply with European electromagnetic compatibility standards, Benschaw Inc. has developed the following guidelines. <p>Attention: This product has been designed for Class A equipment. Use of the product in domestic environments may cause radio interference, in which case the installer may need to use additional mitigation methods.</p>
Enclosure	Install the product in a grounded metal enclosure.
Grounding	Connect a grounding conductor to the screw or terminal provided as standard on each controller. Refer to layout/power wiring schematic for grounding provision location.
Wiring	Wire in an industrial application can be divided into three groups: power control and signal. The following recommendations for physical separation between these groups are provided to reduce the coupling effect; <ul style="list-style-type: none">• Different wire groups should cross at 90 degrees inside an enclosure.• Minimum spacing between different wiring groups in the same tray should be six inches.• Wire runs outside an enclosure should be run in conduit or have shielding/armor with equivalent attenuation.• Different wire groups should be run in separate conduits.• Minimum spacing between conduits containing different wire groups should be three inches (8cm).
Filtering	To comply with Conducted Voltage Limits a 0.33 uF L-G capacitor should be connected to each line at point nearest to the incoming power.

General Information

Installation of some models may require halting production during installation. If applicable, ensure that the starter is installed when production can be halted long enough to accommodate the installation.

Before installing the starter, ensure:

- The wiring diagram (supplied separately with the starter) is correct for the required application.
- The starter is the correct current rating for the motor being started.
- All of the installation safety precautions are followed.
- The correct power source is available.
- The starter control method has been selected.
- The connection cables have been obtained.
- The necessary installation tools and supplies are procured.
- The installation site meets all environmental specifications for the starter NEMA/CEMA rating.
- The motor being started has been installed and is ready to be started.
- Any power factor correction capacitors (PFC) are installed on the power source side of the starter and not on the motor side.



Failure to remove power factor correction or surge capacitors from the load side of the starter will result in serious damage to the starter which will not be covered by the starter warranty. The capacitors must be powered from the line side of the starter. The up-to-speed contact can be used to energize the capacitors after the motor has reached full speed.

Safety Precautions



To ensure the safety of the individuals installing the starter, and the safe operation of the starter, observe the following guidelines:

- Ensure that the installation site meets all of the required environmental conditions (Refer to Site Preparation, page 12).
- **LOCK OUT ALL SOURCES OF POWER.**
- Install circuit disconnecting devices (i.e., circuit breaker, fused disconnect or non-fused disconnect) if they were not previously installed by the factory as part of the package.
- Install short circuit protection (i.e., circuit breaker or fuses) if not previously installed by the factory as part of the package. See page 8 for the fault rating table.
- Follow all NEC (National Electrical Code) and/or C.S.A. (Canadian Standards Association) standards.
- Remove any foreign objects from the interior of the enclosure.
- Ensure that wiring is installed by an experienced electrician.
- Ensure that the individuals installing the starter have protective eye wear and clothing.



The opening of the branch circuit protective device may be an indication that a fault current has been interrupted. To reduce the risk of electrical shock, current carrying parts and other components of the starter should be inspected and replaced if damaged.

3. INSTALLATION

Installation Procedures

To begin installation:

- Read and follow all of the installation safety precautions.
- Procure the necessary installation tools and any supplies.
- Ensure the site has sufficient lighting for safe installation.
- Move the starter to the installation site. Ensure that the starter is positioned so that the cabinet door has ample clearance, and all of the controls are accessible.
- DO NOT install the starter in direct contact with any materials that cannot withstand the heat sink maximum temperature of 194 degrees Fahrenheit (90 degrees Centigrade). All models require airway passages around the heat sink for proper cooling.

If the starter is to be wall mounted:

- Mount the starter on the applicable surface using the appropriate hardware.

NOTE: Moving some models may require more than one individual or lifting equipment (e.g., forklift, crane).

Control Wiring

The control wiring should be connected to suit the customers needs. The control terminals on the control card are as follows:

- TB1-1 Control Power - Line
- TB1-2 Control Power - Neutral
- TB1-3 Start/Stop Relay (K1) - Line 'Seal-In' Contact
- TB1-4 Start/Stop Relay (K1) - Line
- TB1-5 Start/Stop Relay (K1) -Neutral
- TB1-6 Normally Open Fault Contact (not faulted)
- TB1-7 Fault Contact - Common
- TB1-8 Normally Closed Fault Contact (not faulted)
- TB1-9 Normally Open UTS Contact (not UTS)
- TB1-10 UTS Contact - Common
- TB1-11 Normally Closed UTS Contact (not UTS)
- TB1-12 Normally Open Motor Power Contact (no motor power)
- TB1-13 Motor Power Contact - Common
- TB1-14 Normally Closed Motor Power Contact (no motor power)
- TB1-15 External Fault Input - Line
- TB1-16 External Fault Input - Neutral

- TB2-1 Internal power for potentiometer voltage control.
- TB2-2 Voltage or current control signal input.
- TB2-3 Voltage or current control signal common.

NOTE: The up-to-speed contact works as a motor power contact when the starter is in any of the controller modes.

3. INSTALLATION

Power Wiring

Thread the power and motor cables through the correct connector plate opening. Strip away the motor cable insulation and apply anti-oxidation paste to the conductors, if applicable.

Attach the motor cables:

- Use the T1 and T2 lugs or terminals for single-phase wiring.
- Use the T1, T2 and T3 lugs or terminals for three-phase wiring.

Attach the power source cables:

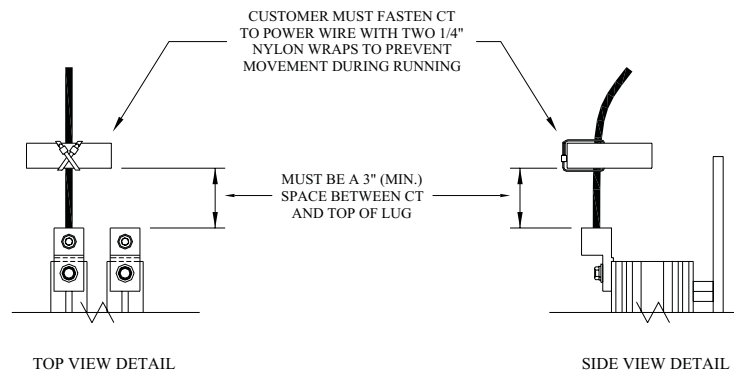
- Use the L1 and L2 lugs or terminals for single-phase wiring.
- Use the L1, L2 and L3 lugs or terminals for three-phase wiring.

The following is a list of the recommended crimp-on wire connectors manufactured by Penn-union Corp.

Wire Size	Part #	Wire Size	Part #
1/0	BLU-1/0S20	500 MCM	BLU-050S2
2/0	BLU-2/0S4	600 MCM	BLU-060S1
3/0	BLU-3/0S1	650 MCM	BLU-065S5
4/0	BLU-4/0S1	750 MCM	BLU-075S
250 MCM	BLU-025S	800 MCM	BLU-080S
300 MCM	BLU-030S	1000 MCM	BLU-100S
350 MCM	BLU-035S	1500 MCM	BLU-150S
400 MCM	BLU-040S4	2000 MCM	BLU-200s
450 MCM	BLU-045S1		

CT Mounting

For larger starters, thread each incoming power cable through its applicable current transformer (CT). The CT must then be attached to the power wiring, at least three inches from the power wire lugs, using two tie-wraps. The cables must be threaded through the CTs in the same direction to ensure normal operations (Refer to the wiring diagram supplied with the starter).



Finishing

After all of the safety precautions and installation procedures have been completed verify that the following settings are correct for the application:

- Motor current transformer (CT) ratio scaling switches.
- Hardware deceleration control (JP1).
- Control mode (TB2) jumpers.

3. INSTALLATION

3.4

CT Ratio Scaling Switches

General Information

The motor current signal scaling is set according to the motor size and the application specified when the starter is ordered. To ensure accurate operation, the motor current signal must be correctly scaled for the motor (and its application) being controlled by the starter.

Motor current signal scaling may have to be changed if:

- Motor size has been changed from the original specification.
- Motor load has been changed from the original application.

Motor current signal scaling is accomplished by verifying the current transformer ratio as supplied with the starter and then selecting the correct DIP switch setting from the chart on the following page for the current transformer ratio. The DIP switches are:

- ON in the UP position
- OFF in the DOWN position

NOTE: The applicable ratio is stamped on each CT. Adjust the DIP switches only when there is no current being supplied to the motor, or the switches could be damaged.

Confirm Switch Settings

To verify or change the motor current signal scaling:

- Compare the CT ratio stamped on each CT to the CT ratio listed on the wiring diagram supplied with the starter to ensure the correct CTs are installed.
- Inspect the control card to ensure that the DIP switches are in the correct positions for the applicable CT ratio and the motor full-load current (FLA) rating.

Switch Settings

P17 = CT Ratio	P1 = Motor FLA	Switch 1	Switch 2
72:1 ¹	2A to 3A	Off/Down	Off/Down
72:1 ¹	5A to 8A	On/Up	Off/Down
72:1 ¹	9A to 16A	Off/Down	On/Up
72:1 ¹	12A to 21A	On/Up	On/Up
144:1 ²	4A to 7A	Off/Down	Off/Down
144:1 ²	10A to 17A	On/Up	Off/Down
144:1 ²	18A to 33A	Off/Down	On/Up
144:1 ²	23A to 43A	On/Up	On/Up
288:1	8A to 14A	Off/Down	Off/Down
288:1	19A to 35A	On/Up	Off/Down
288:1	35A to 66A	Off/Down	On/Up
288:1	46A to 87A	On/Up	On/Up
864:1	22A to 42A	Off/Down	Off/Down
864:1	55A to 105A	On/Up	Off/Down
864:1	104A to 199A	Off/Down	On/Up
864:1	136A to 263A	On/Up	On/Up
2640:1	67A to 128A	Off/Down	Off/Down
2640:1	167A to 322A	On/Up	Off/Down
2640:1	315A to 610A	Off/Down	On/Up
2640:1	416A to 804A	On/Up	On/Up
5760:1	146A to 281A	Off/Down	Off/Down
5760:1	364A to 704A	On/Up	Off/Down
5760:1	688A to 1330A	Off/Down	On/Up
5760:1	906A to 1600A	On/Up	On/Up

Notes:

¹ - Power wire is passed through 288:1 CT four (4) times.

² - Power wire is passed through 288:1 CT two (2) times.

Changing FLA

If the actual motor FLA has been changed from the motor FLA documented on the purchase order:

- Different CTs may have to be installed in the starter.
- The DIP switch positions may need to be changed.
- The current transformer ratio parameter may need to be changed (Refer to current transformer ratio parameter, page 28).

3.5

Hardware Deceleration Control

General Information

Hardware deceleration control is factory disabled when the starter is manufactured unless the purchase order specifically requests that decel control be enabled.

Hardware deceleration control can be enabled or disabled by repositioning a jumper clip.

Hardware deceleration is controlled by jumper JP1 on the control card (Refer to control card layout, page 9). See also section 3.11 for more details.

Jumper	Mode	Position
JP1	Disable	In
JP1	Enable	Out

Whenever hardware deceleration control is enabled, the applicable operating parameters (parameters P8, P9 and P10) must also be set correctly.

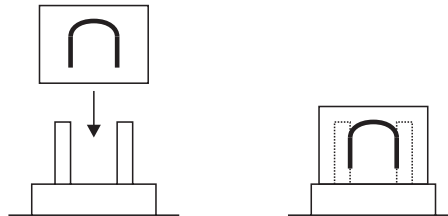
Disable Deceleration

To verify that hardware deceleration control is disabled:

- Inspect the control card to ensure that the jumper clip covers both pins on jumper JP1.

If motor deceleration control is to be disabled, and the jumper clip does not cover both pins on jumper JP1:

- Position the jumper clip so that it does cover both pins on jumper JP1.



Jumper JP1: Motor Deceleration Control Disabled

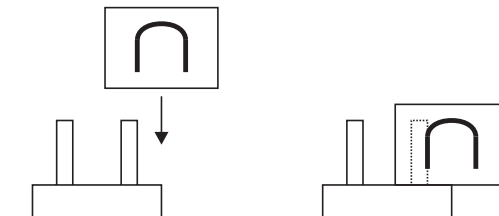
Enable Deceleration

To verify that motor deceleration control is enabled:

- Inspect the control card to ensure that the jumper clip does not cover both pins on jumper JP1.

If motor deceleration control is to be enabled, and the jumper clip covers both pins on jumper JP1:

- Position the jumper clip so that it does not cover both pins on jumper JP1.



Jumper JP1: Motor Deceleration Control Enabled

3. INSTALLATION

3.6	Variable Voltage or Current Input
------------	--

General

The starter can be also used as a voltage or current controller which will provide a voltage or current output proportional to an analog input signal. Parameter P22 - Starter Mode is used to set the operating mode (see page 30). The control options are as follows;

- Potentiometer voltage control using 1kΩ to 10kΩ potentiometer.
- 4 to 20mA external input.
- 0 to 5VDC external input.
- 0 to 10VDC external input.

Changing from the minimum to maximum input will vary the output voltage from 0 to line voltage or current from 0 to the programmed motor FLA value.

NOTE: The analog voltage input is not an isolated input. The installation of an isolation board in the soft-starter cabinet is recommended for mixed wire runs (≥120VAC in same wire-way) or for wire lengths over 20 feet.



Jumper Configuration

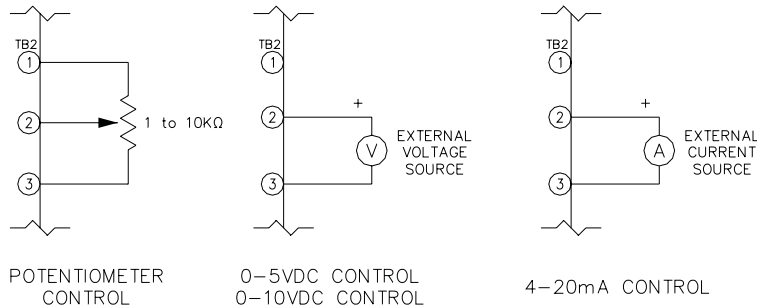
Jumpers JP2, JP3, and JP4 are used to set the starter for the type of input control that is used. The jumpers are configured as follows;

Setting	JP2	JP3	JP4
4-20mA External Control	In	1-2	x
0-5VDC External Control	Out	2-3	1-2
0-10VDC External Control	Out	2-3	2-3
Potentiometer Control	In	Out	x

x = not relevant to setting

Connections

Terminal block TB2 is used for the variable voltage control input. The following connection configurations can be used for the variable voltage control;



3.7	Door Mounted Display
------------	-----------------------------

General

The starter can be supplied with an optional door mounted display. The door mounted display and buttons provides most of the functions of the circuit mounted display and buttons plus it adds an overload reset pushbutton and 4 indicator LEDs for fault, up-to-speed, motor power, and overload. The door mounted display can also be field installed at a later date.

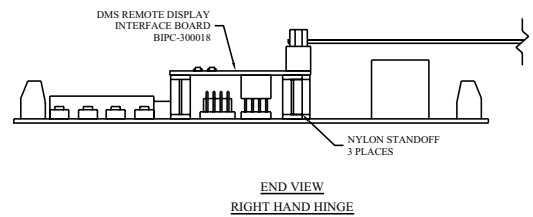
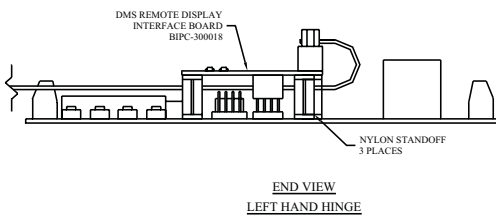
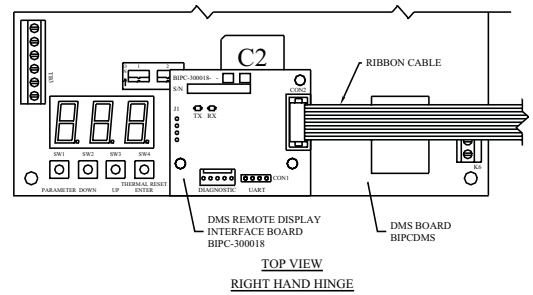
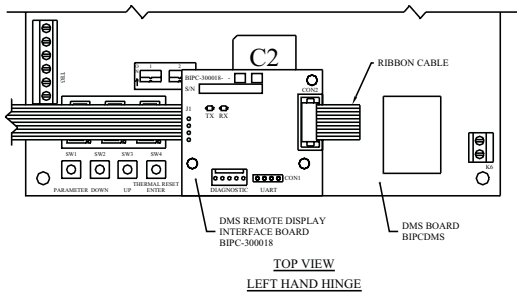
Door Template

Door cut-out detail is provided on page 43 in this manual.

3. INSTALLATION

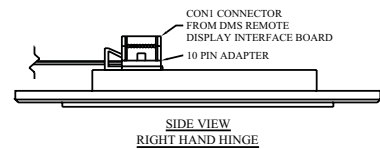
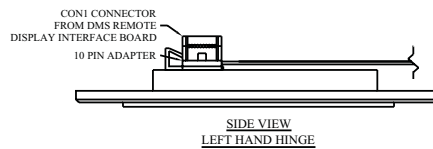
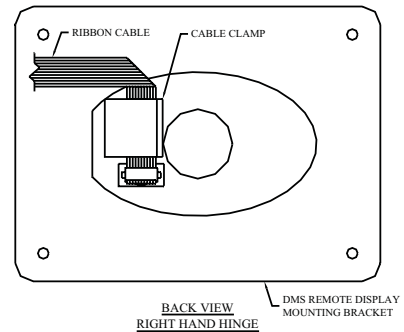
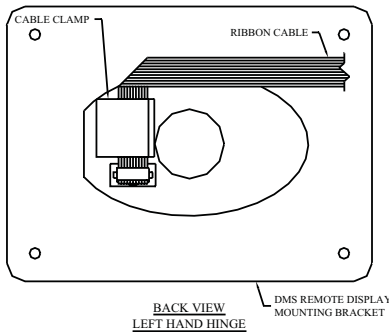
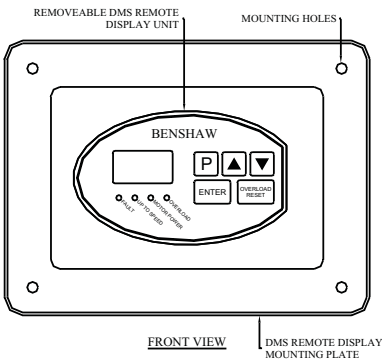
Interface Card

The door mounted display requires the addition of an adapter card to the control card. The door mounted display is then connected to the circuit card with a 10 conductor ribbon cable.



Door Display

The door mounted display performs the same functions as the display and buttons on the circuit card. In addition, the door mounted display adds an overload reset push button. The door mounted display does not support the combination button presses that the circuit board display does.



4. OPERATING PARAMETERS

4.1

General Operating Parameter Information

General Information

To ensure the safe and reliable operation of the starter, it is essential that the operating parameters are correctly programmed before the motor is started.

The operating parameters can be displayed on the control card's three character LED display (or the optional door mounted display). The push buttons underneath the display are used to verify and adjust the parameter values (Refer to the control card diagram, page 9).

The operating parameters can be adjusted for specific applications. Once the operating parameters are set for a specific application, document them on the operating parameters chart (last page of this manual) for future reference.

Parameter Values

Parameter values are displayed on the LED display on the control card. The push buttons underneath the display are used to verify and adjust the parameter value (Refer to the control card diagram, page 9).

NOTE: When verifying or adjusting the parameter value, if the push buttons are not used for 60 seconds, whatever is being displayed will disappear and the normal operating message will reappear. Any parameter that was changed without pressing the Enter button will not be stored.

Parameter values can be changed when the motor is running, but changing a parameter could affect the motor's operation or cause a fault condition.

Incorrect Parameter Values

If the decimal point furthestmost to the right on the red LED display is blinking, the starter has detected a condition which may prevent operation. To identify the pending fault:

At the normal LED display:

- Press the Enter button. The pending (fault if start is pressed) fault code will appear.
- Refer to fault codes, page 36, to determine the incorrect parameter value.
- Press the Enter button to return to the normal LED display.

Parameter Verification

To verify the parameter value in question:

- Ensure the starter is powered-on.
- Press the Parameter (P) button.
- Press the Up or Down buttons until the parameter number is displayed.
- Press the Enter button. The programmed parameter value will appear.
- Verify that the displayed parameter value is the same as the desired value.

Parameter Adjustment

If the displayed parameter value is correct then it does not need to be adjusted. If the displayed parameter value is not correct then it must be changed.

To adjust the parameter value:

- Select the parameter value on the control card's LED display (see parameter verification above).
- Press the applicable Up or Down button until the correct parameter value appears.
- Press the Enter button to program the new parameter value.

If the Enter button is not pressed within 60 seconds after the new parameter value is entered:

- The new parameter value will disappear. It will not be programmed.
- The normal operating message will reappear.
- The previously programmed parameter value will remain programmed.

NOTE: If it is desired not to set the new value, press the Parameter (P) button. This will abort the parameter edit and return to the parameter menu. Press Parameter (P) again to return to the normal display.

4. OPERATING PARAMETERS

4.2

P1 - Motor Full Load Amps

Parameter Description	<p>The motor full load amps parameter must be the same value as the motor's FLA. (The motor's FLA is stamped on the motor nameplate). See page 16 for the possible settings with the CTs supplied and the different burden switch settings.</p> <p>NOTE: If more than one motor is to be started by the same starter, the motor FLA parameter must be the sum of all of the individual motor full load amp ratings.</p> <p>NOTE: At or above 1000 Amps, the actual FLA is displayed by the starter in units of thousands of Amps (e.g., 1.00 = 1000A, 1.01 = 1010A, 1.20 = 1200A).</p>
Parameter Values	<p>The motor FLA parameter values range from 1 Amp through 1200 Amps.</p> <ul style="list-style-type: none">• Parameter values from 1 Amp through 999 Amps are set in 1 Amp increments.• Parameter values from 1000 Amps through 1200 Amps are set in 10 Amp increments. <p>NOTE: In current controller mode (CnE) this parameter represents the 100% current level.</p>
Parameter Default	<p>The motor FLA parameter's default value is 1 Amp.</p>

4.3

P2 - Overload Multiplier

Parameter Description	<p>The motor overload multiplier parameter should be set to the same value as the motor's service factor. (The motor's service factor is stamped on the motor nameplate).</p> <p>The motor overload multiplier affects the overload relay maximum tripping percentage as indicated in the NEC article 430. The overload multiplier indicates the maximum continuous running motor current over that marked on the motor nameplate. For example, a motor with a marked FLA of 126 amps and a 1.15 overload multiplier may be run at $126 \times 1.15 = 150$ amps continuous.</p> <p>NOTE: P2 is not used in any of the controller modes.</p>
Parameter Values	<p>The motor overload multiplier parameter values are:</p> <ul style="list-style-type: none">• 1.00• 1.05• 1.10• 1.15• 1.20• 1.25• 1.30• 1.35• 1.40
Parameter Default	<p>The motor overload multiplier parameter's default value is 1.15.</p>

4. OPERATING PARAMETERS

4.4

P3 - Motor Thermal Overload

Parameter Description

The motor thermal overload parameter helps protect the motor from overheating within the standard NEMA classification.

NOTE: When the motor thermal overload parameter is set to OFF, the starter does not provide motor thermal overload protection. **In this case, an external means of motor protection must be provided.**

NOTE: Verify the selected overload class is acceptable. Contact the motor manufacturer for stall time damage curves.

From a cold motor start:

- A class 10 overload will trip the starter and activate the fault relay in 10 seconds at 600% of the Motor FLA.
- A class 20 overload will trip the starter and activate the fault relay in 20 seconds at 600% of the Motor FLA.
- A class 30 overload will trip the starter and activate the fault relay in 30 seconds at 600% of the Motor FLA.

Parameter Values

The motor thermal overload parameter values are:

- Class 10
- Class 20
- Class 30
- Off

Parameter Default

The motor thermal overload parameter's default value is class 10.

4.5

P4 - Initial Motor Starting Current

Parameter Description

The initial motor starting current parameter is the percentage of the full load amps (P1) initially delivered to the motor when it is started. It should be set to a level that allows the motor to begin accelerating as soon as a start is commanded.

If the motor does not begin to accelerate immediately after a start is commanded, then increase this parameter value. If the motor begins accelerating too quickly when a start is commanded, decrease this parameter value.

NOTE: P4 is not used in any of the controller modes.

Parameter Values

The initial motor starting current parameter values range from 50% to 400%. Parameter values are set in 5% increments (i.e., 55%, 60%, 65%).

Parameter Default

The initial motor starting current parameter's default value is 100%.

4. OPERATING PARAMETERS

4.6

P5 - Maximum Motor Starting Current

Parameter Description

The maximum motor starting current parameter limits the amount of current delivered to the motor during motor start-up and normal motor operation. Its value is expressed as a percentage of the full load amps (P1) setting.

During motor start-up the motor current may not reach this setting. The maximum motor starting current setting is reached only when it is required to start the load.

In all cases, the maximum motor starting current must be set high enough to enable the motor to accelerate to full speed under all load conditions.

NOTE: The motor's speed should be monitored during start-up to ensure that full speed is achieved with the set maximum motor starting current value.

The maximum motor starting current value may need to be reduced for constant current applications in order to limit the motor's peak starting current. If the maximum motor starting current is set below the initial current value, the starter will perform a constant current start, holding the current at the maximum motor starting current parameter value.

NOTE: P5 is not used in any of the controller modes.

NOTE: Once the motor is up to speed, the starter does not attempt to regulate current.

Parameter Values

The maximum motor starting current parameter values range from 200% through 600%. Parameter values are set in 5% increments (i.e., 205%, 210%, 215%).

Parameter Default

The maximum motor starting current parameter's default value is 600%.

4.7

P6 - Motor Ramp Time

Parameter Description

The motor ramp time parameter sets the amount of time (in seconds) that the starter will smoothly ramp from the selected initial motor current parameter value to the selected maximum motor current parameter value.

For many applications, the motor and the driven load do not require the set current level or ramp time to achieve full speed. If the motor's acceleration during start-up is acceptable, then no further adjustments are necessary.

NOTE: If the motor accelerates too quickly, increase ramp time. If the motor accelerates too slowly, decrease ramp time.

NOTE: P6 is not used in any of the controller modes.

NOTE: If a motor ramp time parameter value of 0 seconds is selected with a maximum motor current parameter value of 600%, the starter will act as a solid state contactor and the motor will start instantaneously without ramping. This is similar to a full voltage or across-the-line start.

Parameter Values

The motor ramp time parameter values range from 0 seconds through 120 seconds. Parameter values are set in 1 second increments.

Parameter Default

The motor ramp time parameter's default value is 15 seconds.

4. OPERATING PARAMETERS

4.8

P7 - Motor Stall Time

Parameter Description	<p>The motor stall time parameter sets the amount of time (in seconds), from the beginning of the ramp time that the starter will give the motor to achieve its full operating speed before the starter disconnects the motor's current and displays a fault message.</p> <p>NOTE: P7 is not used in any of the controller modes.</p> <p>NOTE: Stall time must be greater than ramp time or a stall will always occur.</p>
Parameter Values	<p>The motor stall time parameter values range from 0 seconds through 240 seconds. Parameter values are set in 1 second increments.</p>
Parameter Default	<p>The motor stall time parameter's default value is 30 seconds.</p>

4.9

P8 - Deceleration Level 1

Parameter Description	<p>The motor deceleration level 1 parameter is the initial percentage of line voltage delivered to the motor after a Stop command has been received.</p> <p>NOTE: The motor deceleration level 1 parameter is not functional when the motor deceleration control jumper JP1 on the control card is in the disabled position or if the motor deceleration time (P10) parameter is set to OFF (Refer to motor deceleration time parameter, page 25).</p> <p>If the motor initially surges when a stop is commanded, decrease this parameter value. If the motor has a large, sudden drop in speed when a stop is commanded, increase this parameter value.</p> <p>NOTE: P8 is not used in any of the controller modes.</p>
Parameter Values	<p>The motor deceleration level 1 parameter values range from 0% through 100%. Parameter values are set in 1% increments.</p>
Parameter Default	<p>The motor deceleration level 1 parameter's default value is 40%.</p>

4. OPERATING PARAMETERS

4.10

P9 - Deceleration Level 2

Parameter Description

The motor deceleration level 2 parameter is the final percentage of line voltage delivered to the motor after a Stop command has been received, and the time determined by the motor deceleration time (P10) parameter has expired.

The motor deceleration level 2 parameter is not functional if the motor deceleration control jumper JP1 on the control card is in the disabled position or if the motor deceleration time (P10) parameter is set to OFF (Refer to motor deceleration time parameter, page 25).

If the motor is still rotating when the deceleration time has expired, decrease this parameter value. If the motor stops rotating before the deceleration time has expired, increase this parameter value.

NOTE: P9 is not used in any of the controller modes.

Parameter Values

The motor deceleration level 2 parameter values range from 0% through 100%. Parameter values are set in 1% increments.

NOTE: The motor deceleration level 2 parameter's value must be less than the motor deceleration level 1 parameter's value. If the deceleration level 2 parameter is set higher than the deceleration level 1 parameter, the starter will swap the deceleration level 1 and deceleration level 2 settings when decel is commanded.

Parameter Default

The motor deceleration level 2 parameter's default value is 10%.

4.11

P10 - Deceleration Time

Parameter Description

The motor deceleration time parameter sets the deceleration time from motor deceleration level 1 to motor deceleration level 2. Deceleration time is the amount of time during which the starter will gradually reduce the amount of line voltage being delivered to the motor (after a Stop command has been received).

The motor deceleration time parameter is not functional when the motor deceleration control jumper JP1 on the control card is in the disabled position.

When this parameter is set to any value other than OFF, the motor deceleration Level 1 and motor deceleration Level 2 parameters must be programmed.

When the motor deceleration time parameter is set to OFF, the motor deceleration level 1 and motor deceleration level 2 parameters are disabled.

If the motor is still rotating when the deceleration time expires, increase the deceleration time. If the motor stops rotating before the deceleration time expires, decrease the deceleration time.

NOTE: If the motor deceleration time parameter is set to OFF, the motor's deceleration is not controlled by the starter. If the motor needs to be stopped faster than the time it takes to coast to a stop, the deceleration control will not help.

NOTE: P10 is not used in any of the controller modes.

NOTE: If deceleration jumper JP1 is in place and deceleration time is programmed, the deceleration will not operate. The deceleration timer will block a restart attempt until it has timed out. This can operate as a blocked restart timer for up to 1 minute. This is useful for reversing starters or dual starters.

Parameter Values

The motor deceleration time parameter values range from OFF to 60 seconds. Parameter values are set in 1 second increments.

Parameter Default

The motor deceleration time parameter's default value is OFF.

4. OPERATING PARAMETERS

4.12

P11 - Overcurrent Trip Level

Parameter Description	<p>The overcurrent trip level parameter sets the high current level trip point as a percentage of motor full load amps parameter P1. The overcurrent trip level parameter takes effect after the motor is up to speed. This protection feature is also referred to as mechanical jam protection.</p> <p>NOTE: The overcurrent trip level parameter is not operational if the overcurrent trip time parameter (P12) is set of OFF.</p>
Parameter Values	<p>The overcurrent trip level parameter values range from 50% through 400%. Parameter values are set in 5% increments.</p>
Parameter Default	<p>The overcurrent trip level parameter's default value is 50%.</p>

4.13

P12 - Overcurrent Trip Time

Parameter Description	<p>The overcurrent trip time parameter sets the length of time that the load current can continuously exceed the overcurrent trip level before a fault is generated.</p>
Parameter Values	<p>The overcurrent trip time parameter values range from OFF through 15 seconds. Parameter values are set in one second increments.</p> <p>Rxx indicates the fault will auto-restart after tripping in xx seconds. Lxx indicates the fault will require manual reset after tripping in xx seconds.</p>
Parameter Default	<p>The overcurrent trip time parameter's default value is OFF.</p>
Parameter Order	<p>R 15 R 14 . . . R02 R0 1 OFF L 15 L 14 . . . L02 L0 1</p>

4.14

P13 - Undercurrent Trip Level

Parameter Description	<p>The undercurrent trip level parameter sets the low current level trip point as a percentage of motor full load amps parameter (P1). The undercurrent trip level parameter takes effect after the motor is up to speed.</p> <p>NOTE: The undercurrent trip level parameter is disabled if the undercurrent trip time parameter P14 is set to OFF.</p>
Parameter Values	<p>The undercurrent trip level parameter values range from 25% through 100%. Parameter values are set in 5% increments.</p>
Parameter Default	<p>The undercurrent trip level parameter's default value is 25%.</p>

4. OPERATING PARAMETERS

4.15

P14 - Undercurrent Trip Time

Parameter Description	The undercurrent trip time parameter sets the length of time that the load current can continuously be less than the undercurrent trip level before a fault is generated.
Parameter Values	<p>The undercurrent trip time parameter values range from OFF through 15 seconds. Parameter values are set in one second increments.</p> <p>Flxx indicates the fault will auto-restart after tripping in xx seconds. Lxx indicates the fault will require manual reset after tripping in xx seconds.</p>
Parameter Default	The undercurrent trip time parameter's default value is OFF.
Parameter Order	<pre>A 15 A 14 . . . A02 A01 OFF L 15 L 14 . . . L02 L01</pre>

4.16

P15 - Line Phase Sensitivity

Parameter Description	<p>The power line phase sensitivity parameter sets the power line phase order being expected by the starter. If the starter detects that the phase order is the wrong sequence, it will display a fault code. When the power line phase sensitivity parameter value is set to INS, the starter will start the motor regardless of the actual incoming power line phase order.</p> <p>NOTE: The power line's phase order affects the motor's rotation direction. To ensure safe and effective motor operation the power line phase sensitivity parameter should be set according to the line phasing being delivered by the power source.</p>
View Phase Order	<p>To display the actual power line phase order into the starter, at the normal LED display:</p> <ul style="list-style-type: none">• Press the UP push button and the incoming power line phase order, ABC or CBA will appear.• Set the power line phase sensitivity parameter accordingly.
Parameter Values	<p>The power line phase sensitivity parameter values are:</p> <ul style="list-style-type: none">• ABC• CBA• INS (insensitive)• SPH (single phase)
Parameter Default	The line phase sensitivity default value is INS.

4. OPERATING PARAMETERS

4.17

P16 - Motor Current Imbalance

Parameter Description	<p>The motor current imbalance parameter sets the percentage of acceptable difference between the line-to-line currents. If the difference exceeds the set percentage for more than 10 seconds, the starter will issue a fault message and remove power from the motor.</p> <p>NOTE: Current imbalances will be ignored if the average line current is < 40%.</p>
Parameter Values	<p>The motor current imbalance parameter values range from 5% through 40%. Parameter values are set in 5% increments.</p>
Parameter Default	<p>The motor current imbalance parameter's default value is 20%.</p>

4.18

P17 - Current Transformer Ratio

Parameter Description	<p>The current transformer ratio parameter is factory set to match the current transformers (CTs) installed in the package. The CTs are used to accurately measure the line current being delivered to the motor.</p> <p>NOTE: If the CTs installed in the package are changed to CTs with a different ratio, the current transformer ratio parameter must be changed. The CTs are custom manufactured by Benshaw. The applicable CT Ratio is stamped on the CT.</p>
Parameter Values	<p>The current transformer ratio parameter values are:</p> <ul style="list-style-type: none">• 72 (72:1) - Wire passes through 288:1 CT four (4) times.• 96 (96:1) - Wire passes through 288:1 CT three (3) times.• 144 (144:1) - Wire passes through 288:1 CT two (2) times.• 288 (288:1)• 864 (864:1)• 2.64 (2640:1)• 2.88 (2880:1)• 5.76 (5760:1)
Parameter Default	<p>The current transformer ratio parameter's default value is 288.</p>

4.19

P18 - Meter Mode

Parameter Description	<p>The meter mode parameter sets what the display on the starter will indicate. The starter has the capability of displaying different metered values on the display depending on this parameter setting.</p> <p>NOTE: When this parameter is set from 0 to 5, the user must press the Enter pushbutton, while the starter is running, to view the selected meter function.</p>
Parameter Values	<p>The meter mode parameter values are:</p> <ul style="list-style-type: none">• 0 - Average phase current.• 1 - L1 phase current.• 2 - L2 phase current.• 3 - L3 phase current.• 4 - Maximum phase current.• 5 - Current imbalance level.• 10 - Automatically display average phase current when started.• 11 - Automatically display L1 phase current when started.• 12 - Automatically display L2 phase current when started.• 13 - Automatically display L3 phase current when started.• 14 - Automatically display Maximum phase current when started.• 15 - Automatically display current imbalance level when started.
Parameter Default	<p>The meter mode parameter's default value is 10.</p>

4. OPERATING PARAMETERS

4.20

P19 - Meter Dwell Time

Parameter Description	The meter dwell time parameter sets the time between meter updates. Each time the meter updates, the starter will display the highest value reached since the last update. This feature can be used to view the peak currents reached during starting or during a repetitive process.
Parameter Values	The meter dwell time parameter values are off or 2 to 30 seconds. The meter dwell time is set in 2 second intervals.
Parameter Default	The meter dwell time parameter's default value is 2 seconds.

4.21

P20 - Passcode

Parameter Description	<p>The passcode feature allows the user to protect the parameters from unauthorized modifications.</p> <p>When entering the parameter, if the display momentarily shows $\square 15$:</p> <ul style="list-style-type: none">• Parameter protection is disabled and parameters can be modified.• Use the Up and Down buttons to select a passcode.• When a passcode is entered, the display will show $\square 17$ and the starter parameters are protected. <p>When entering the parameter, if the P20 display momentarily shows $\square 17$:</p> <ul style="list-style-type: none">• Parameter protection is enabled and the starter parameters cannot be modified.• Use the Up and Down buttons to select the previously set passcode.• When correct passcode is selected and the Enter button is pressed, the display will show $\square 15$ and the starter parameters can be modified.• Once the proper passcode is entered and the display shows $\square 15$, the passcode can be reset back to $\square FF$ to disable passcode protection. <p>If a parameter change is attempted while the parameters are passcode protected, the display will flash $\square \square$ and the parameter will not be changed.</p>
Parameter Values	The passcode parameter can be set to $\square FF$ (disabled) or from 1 to 255.
Parameter Default	The passcode parameter's default value is $\square FF$ (disabled).

4.22

P21 - 500% Current Kick Time

Parameter Description	<p>The 500% current kick time allows the user to program a 500% current override at the beginning of the current ramp profile. This 500% current kick will be provided to the motor for the time programmed. The 500% current kick can be used to start a motor with a very high break-away torque requirement.</p> <p>NOTE: If current transformers are not used, the unit will do a full voltage kick in $\square 1$ or $\square 2$ mode.</p>
Parameter Values	The 500% current kick time parameter can be set to $\square FF$ or from 0.1 to 5.0 seconds in 0.1 second intervals.
Parameter Default	The 500% current kick time parameter's default value is $\square FF$ (disabled).

4. OPERATING PARAMETERS

4.23

P22 - Starter Mode

Parameter Description



The starter mode parameter allows the user to set the operating mode of the starter. The starter can be operated in the closed loop current ramp motor starting mode or in an open loop voltage controller mode. The current ramp is used for standard motor starting. The voltage controller is used for heater control or other similar applications.

See page 18 for a description of the control methods, hardware settings, and wiring.

When the starter mode is changed, the circuit card must be fully reset by pressing the Parameter and Enter buttons simultaneously causing a circuit card reset.

NOTE: The starter will fault on F60 if $< 4\text{mA}$ is read on TB2 in any of the 4-20mA modes. If start is not commanded, a pending fault will be indicated.

Parameter Values

The starter mode parameter can be set to

- $\square\square\square$ - Current ramp operating mode.
- $\square\square 1$ - 4-20mA open loop voltage.
- $\square\square 2$ - 0-5V/0-10V or potentiometer open loop voltage.
- $\square\square 3$ - 4-20mA closed loop 0-100% FLA current mode.
- Consult factory for tachometer feedback.

Parameter Default

The starter mode parameter's default value is $\square\square\square$.

General Information	The pushbuttons on the control card under the 7-segment display perform a number of different functions.
Parameter Pushbutton	The Parameter (P) pushbutton performs the following functions: <ul style="list-style-type: none">• While in normal display mode:<ul style="list-style-type: none">- Enter parameter menu and exit.- Reset the CPU when pressed in conjunction with the Up pushbutton.• While in parameter editing mode:<ul style="list-style-type: none">- Abort editing of a parameter and return to parameter menu.
Down Pushbutton	The Down pushbutton performs the following functions: <ul style="list-style-type: none">• While in normal display mode:<ul style="list-style-type: none">- Toggle display of overload content.- Perform an emergency reset if pressed in conjunction with the Enter pushbutton while $\square LL$ is displayed (card display only).• While in parameter selecting mode (Pxx on display):<ul style="list-style-type: none">- Move to previous parameter.• While in parameter editing mode:<ul style="list-style-type: none">- Decrease parameter value.
Up Pushbutton	The Up pushbutton performs the following functions: <ul style="list-style-type: none">• While in normal display mode:<ul style="list-style-type: none">- Toggle display of incoming line phase.- Reset the CPU when pressed in conjunction with the Parameter pushbutton.• While in parameter selecting mode (Pxx on display):<ul style="list-style-type: none">- Move to next parameter.• While in parameter editing mode:<ul style="list-style-type: none">- Increase parameter value.
Enter Pushbutton	The Enter pushbutton performs the following functions: <ul style="list-style-type: none">• While in normal display mode:<ul style="list-style-type: none">- Display pending fault code if pressed when starter is stopped and the right dot is flashing.- Perform an emergency reset if pressed in conjunction with the Down pushbutton while $\square LL$ is displayed (card display only).- Perform a thermal reset when $\square LE$ is displayed.- Toggle the meter display when the starter is running.• While in parameter selecting mode (Pxx on display):<ul style="list-style-type: none">- Enter parameter editing mode.• While in parameter editing mode:<ul style="list-style-type: none">- Save displayed value and return to parameter selecting mode.
Overload Reset	The overload reset performs the following functions (remote door display only). <ul style="list-style-type: none">• While $\square LE$ is displayed on the 7-segment display:<ul style="list-style-type: none">- Resets the thermal overload and allows the motor to be started.

5. OPERATING PROCEDURES

5.2

Starting The Motor

General Information

For safe and reliable operation of the starter and the motor ensure:

- All of the starting the motor procedures are conducted by a trained technician.
- The starter has the correct voltage and current rating for the motor.
- Any power factor correction (PFC) capacitors are installed on the power source side of the starter and not on the motor side.
- The starter has been installed correctly (Refer to Installation Procedures, page 13).
- The operating parameters have been verified (Refer to Parameters, page 20).
- The motor and its load are safe and ready to be started.
- No personnel or equipment are near the motor.

CAUTION: Hazardous voltages may exist at the motor when power is applied to the terminals of the starter even if the starter is in the OFF state.

Starting the Motor

As the motor is being started, it may be necessary to adjust the following parameters in order to achieve optimal motor performance and protection:

- Motor thermal overload class P3.
- Initial motor current parameter P4.
- Maximum motor current parameter P5.
- Ramp time parameter P6.
- Motor deceleration time parameter P10.
- Power line phase sensitivity parameter P15.

When initially starting the motor, briefly initiate the Start command and then the Stop command. Observe the motor to ensure:

- It begins to rotate slowly as soon as it receives the start command.
- It rotates in the correct direction.

If the motor does not rotate:

- Increase the initial motor current parameter (P4).
- If the motor will not rotate, refer to the Starter Diagnostics on page 38.

If the motor rotates in the wrong direction:

- LOCK OUT ALL POWER SOURCE(S).
- Switch any two of the power or motor cable connections.
- Repeat the start-stop sequence to ensure correct rotation.

If the motor begins to rotate in the correct direction (after an initial start and stop command).

- Apply a Start command.

As the motor is accelerating:

- Observe the motor to ensure that it smoothly accelerates to full speed.
- \overline{ACC} or the meter function is displayed on the control card LED display indicates that the motor is accelerating.

When the motor achieves full operating speed:

- $\overline{H5}$ or the meter function is displayed on the LED display on the control card.
- The up to speed relay will energize.

When the starter is operating and the ramp time has expired:

- \overline{RPT} or the meter function is displayed on the LED display on the control card.

NOTE: If any other operating message is displayed, refer to Operating Messages, page 35. If a fault code is displayed, refer to Fault Codes, page 36.

Running Checks

Measure the AC voltage between:

- L1 terminal and T1 terminal.
- L2 terminal and T2 terminal.
- L3 terminal and T3 terminal.

5. OPERATING PROCEDURES

Ensure that each voltage measurement is less than 2 VAC.

Other Checks:

- Measure the current on the motor cables to verify that the current on the motor cables is balanced and each line is within acceptable amperage limits.
- Measure the motor shaft speed with a tachometer to confirm that the motor is operating at rated speed.

CAUTION: Hazardous voltages exist at the starter terminals. Use extreme caution when measuring the voltages.

Thermal Overload

The thermal overload provides motor thermal protection. It is designed so that the percentage of overload will follow the thermal content of the motor. The starter uses the current to model the motor temperature. The starter also models the running heat in the motor by lowering the allowable overload time depending on the motor load (see page 7 for the overload curves).

The thermal overload will settle at the following thermal content percentages, according to the motor load:

- 10% - When the motor current is between 0% and 50% of the FLA value.
- 20% - When the motor current is between 50% and 75% of the FLA value.
- 30% - When the motor current is between 75% and 100% of the FLA value.

Once the thermal overload has tripped, the starter will take the following times to cool down, which are dependant on the class of the overload:

- Class 10 overload - 6 minutes
- Class 20 overload - 12 minutes
- Class 30 overload - 18 minutes

To ensure that the motor will not overheat during normal operations check the motor thermal overload content. At the normal LED display:

- Press the Down push button on the control card or remote door display.
- The percentage of the motor's total thermal capacity (i.e., the motor thermal overload content) will appear on the red LED Display.
- Ensure that the motor thermal capacity is not increasing past the hot running value, as listed above, during normal operation. It will rise during starting and then it should settle once the motor is up to speed.
- Press the Down push button on the control card or remote door display to return to the normal LED display.

NOTE: If power to the control card is removed, all motor thermal overload content information stored by the starter will be lost. Caution should always be used to ensure that a thermally overloaded motor is not started as if it were a cold motor.

CAUTION: Except in emergencies, allow a thermally overloaded motor to cool before restarting it. This will prevent damaging the motor.

Resolving Overload Trips

The National Electrical Code, article 430 Part C, allows for different overload multiplier factors depending on the motor and operating conditions.

NEC section 430-32 outlines the allowable overload multiplier (P2) for different motors as follows:

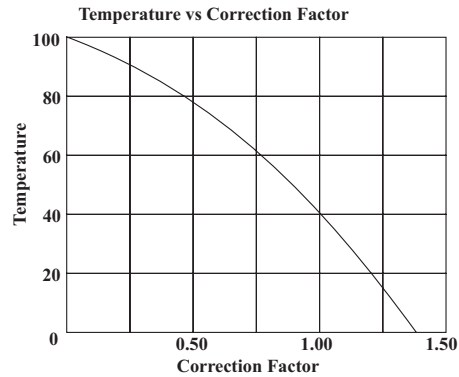
Motor	Overload Multiplier
Service factor 1.15 or more	1.25
Motor temp. rise 40°C or less	1.25
All others	1.15

NEC section 430-34 permits further modifications if the overload multiplier (P2) is not sufficient to start the motor:

Motor	Overload Multiplier
Service factor 1.15 or more	1.40
Motor temp. rise 40°C or less	1.40
All others	1.30

5. OPERATING PROCEDURES

Although the NEC doesn't address the effect of the ambient temperature of the motor location, guidance can be derived by examining NEC limits. If the motor is operating in an ambient temperature that is less than 40°C, then the overload multiplier can be increased while still protecting the motor from exceeding its maximum designed temperature. The following curve gives the ambient temperature vs the correction factor.



For example; If a motor operates at 0°C then a 1.36 correction factor could be applied to the overload multiplier. This could give a theoretical overload multiplier of 1.36 x 1.25 or 1.70. The highest legal value of overload multiplier is 1.40 so this could be used.

Overload Emergency Reset

In emergency cases, when a thermally overloaded motor must be restarted before it has cooled, and the power to the starter cannot be easily removed, the motor thermal content emergency reset can be used to delete motor thermal overload content information from the starter so that the motor can be restarted.

To reset the motor thermal content in an emergency:

- Press the Down button and Enter buttons simultaneously on the control card.
- All motor thermal overload content information stored by the starter will be deleted, and the motor may be restarted.

General Information

Operating messages are displayed on the three-character LED display on the control card. The LED display on the control card displays:

- Operating messages that indicate the status of the motor and/or starter.
- Operating parameters that are programmed (Refer to page 20 for information on operating parameters).
- Fault codes that indicate a problem with the motor application or starter (Refer to page 36 for information on fault codes).

Operating Messages The possible operating messages are as follows.

Message	Meaning
n0.L	Line voltage is not present.
r09	Line voltage is present and the starter is ready.
Rcc	Motor is accelerating after a start command has been received.
uE5	The motor has achieved full speed.
r0n	Motor is operating at full speed, and ramp time is expired.
dCL	A Stop command was received and the motor is decelerating with the set deceleration profile.
□L	□L will alternately blink with the normal display on the LED display when motor thermal overload content has reached 90% to 99% of its capacity.
□LL	The motor thermal overload content has reached 100%, and the motor has been stopped. The motor cannot be restarted until the overloaded motor has cooled and □LE is displayed.
□LE	The motor thermal overload content has been reduced to 60% or less, and the motor may be restarted.
EnA	Passcode protection is enabled.
d IS	Passcode protection is disabled.
□xx	xx = overload thermal content in percentage. Press the Down button to toggle to this display.
cxx	xx = pending fault
Fxx	xx = fault code
n□	Attempted to change a passcode protected parameter.
. . .	Three decimal places blink when remote display is active.
Rxx	Automatically reset over/undercurrent fault after tripping in xx seconds.
Exx	Manual reset over/undercurrent fault after tripping in xx seconds.

5. OPERATING PROCEDURES

5.4

Fault Codes

General Information

Fault codes will be displayed on the red, three-character LED display. Fault Codes indicate a problem with the starter or motor application.

Fault Reset

To recover from a fault, perform a computer reset by pressing Parameter & Up buttons simultaneously on the circuit board or by cycling the power to the control card.

Code	Fault	Possible Solutions
F1	Power line phase sensitivity parameter set to ABC for CBA line sequence.	Exchange any two incoming line connections or change the phase sensitivity parameter.
F2	Power line phase sensitivity parameter set to CBA for ABC line sequence.	Exchange any two incoming line connections or change the phase sensitivity parameter.
F3	System power is not three phase.	Check for missing line or reset starter to single phase operation.
F4	System power is not single phase.	Ground unused phase, check for missing line power, or reset starter to three phase operation.
F5	Line frequency is less than 25hz.	Check the power line frequency to the starter. Correct the power source.
F6	Line frequency is greater than 75hz.	Check the power line frequency to the starter. Correct the power source.
F23	Line current imbalance is greater than set current imbalance level.	Correct the cause of the motor current imbalance or increase the motor current imbalance parameter P16.
F24	Line currents became very unbalanced while the motor was running.	Check line currents going through the current transformers for an unbalanced condition. Check the starter for possible shorted SCRs
F29	Operating parameters have been lost.	Load the default parameters. Verify all operating parameters are set correctly.
F30	Three phase default parameters have been loaded.	This is only a message, not a fault.
F31	Single phase default parameters have been loaded.	This is only a message, not a fault.
F52	A Motor current greater than 12.5% was detected while the motor was stopped.	Check starter for shorted SCR's or other problems which would lead to a current while stopped.
F54	An undercurrent trip has occurred.	Check the undercurrent trip level parameter P13. Check the application for the undercurrent problem.
F55	An overcurrent trip has occurred.	Check the overcurrent trip level parameter P11. Check the application for the overcurrent problem.
F60	No control	Check if there is < 4mA on TB2 when in 4-20mA controller mode.
F70	Control power is too low.	Correct low power condition.
F71	Motor current transformer scaling switches were changed while the motor was running.	Set switches to the correct positions. Changing the switches while the motor is running may cause damage to the switches.
F74	The motor stalled while accelerating.	Verify that the parameters are set to allow proper motor acceleration (P1, P4, P5, P6, P7).
F75	External fault.	Check for 120VAC input into TB1 terminals 15 and 16.
F77	Control card fault.	Reset. Consult factory if fault persists.
F78	Control card fault.	Reset. Consult factory if fault persists.
F90	Incorrect set-up.	Full-load amps (P1), CT ratio (P17), or CT burden select switch set incorrectly.
F92	A shorted SCR was detected during acceleration.	Check SCRs.
F97	Control card fault.	Reset. Consult factory if fault persists.
F98	Line power was missing when Start command was given or while starter was operating the motor.	Check the incoming line power connections. Verify any protection or control devices are connected correctly and are operational.
F99	Load current very high.	Check load for shorts and other faults that would cause a high current condition.

5. OPERATING PROCEDURES

5.5

Preventative Maintenance

General Information

Preventive maintenance performed on a regular basis will help ensure that the starter continues to operate reliably and safely. The frequency of preventive maintenance depends upon the type of maintenance and the installation site's environment.

NOTE: Preventive maintenance should always be performed by a trained technician.

Preventive Maintenance

During Commissioning;

- Torque all power connections during commissioning. This includes pre-wired equipment.
- Check all of the control wiring in the package for loose connections.

For the first month after the starter has been put in operation;

- Re-torque all power connections every two weeks. This includes pre-wired equipment.
- Inspect the cooling fans after two weeks to ensure proper operation.

After the first month of operation;

- Re-torque all power connections every year.
- Clean any accumulated dust from the starter using a clean source of compressed air.
- Inspect the cooling fans every three months to ensure proper operation.
- Clean or replace any air vent filters on the starter every three months.

NOTE: If mechanical vibrations are present at the installation site, inspect the connections more frequently.

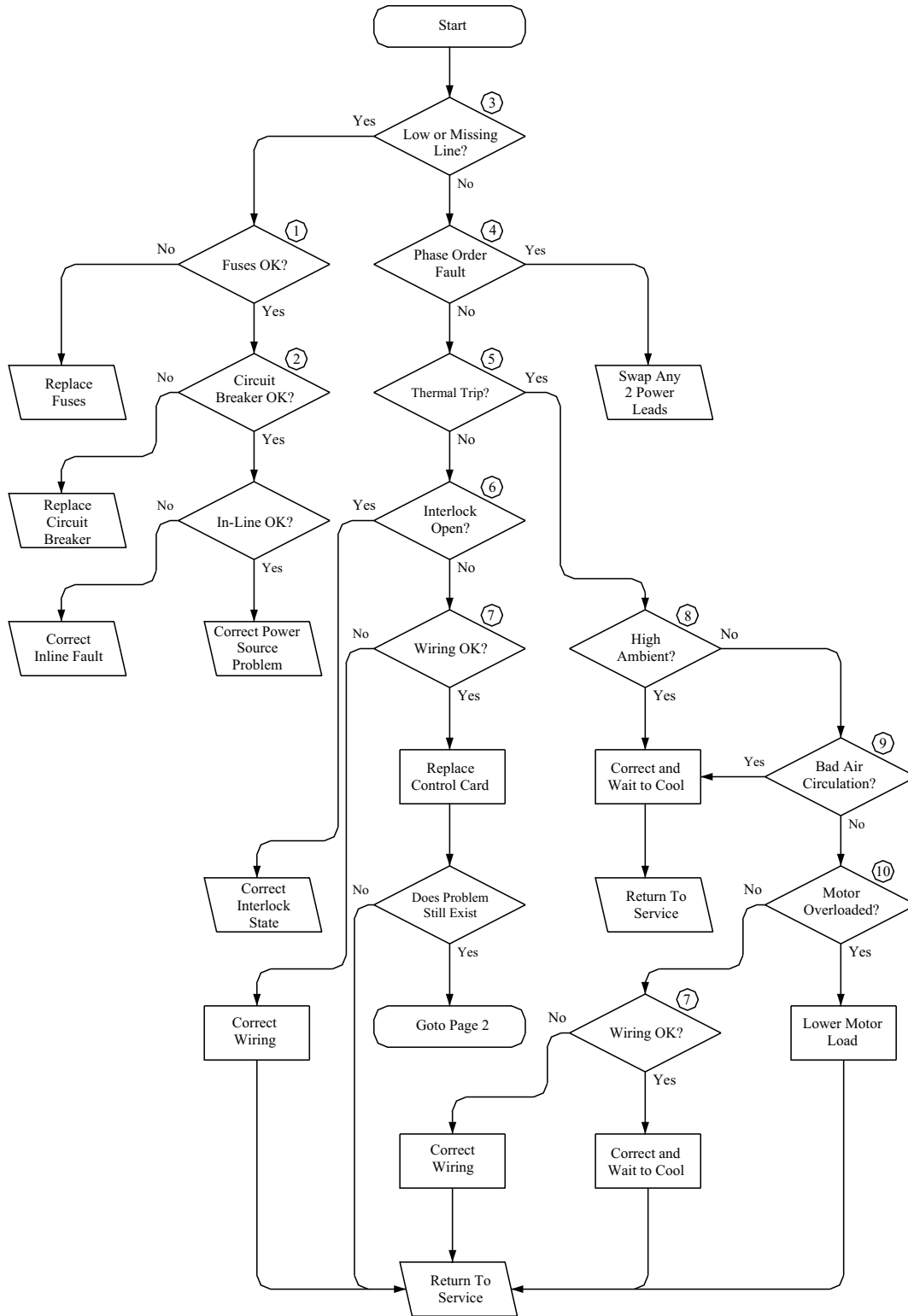
5. OPERATING PROCEDURES

5.6

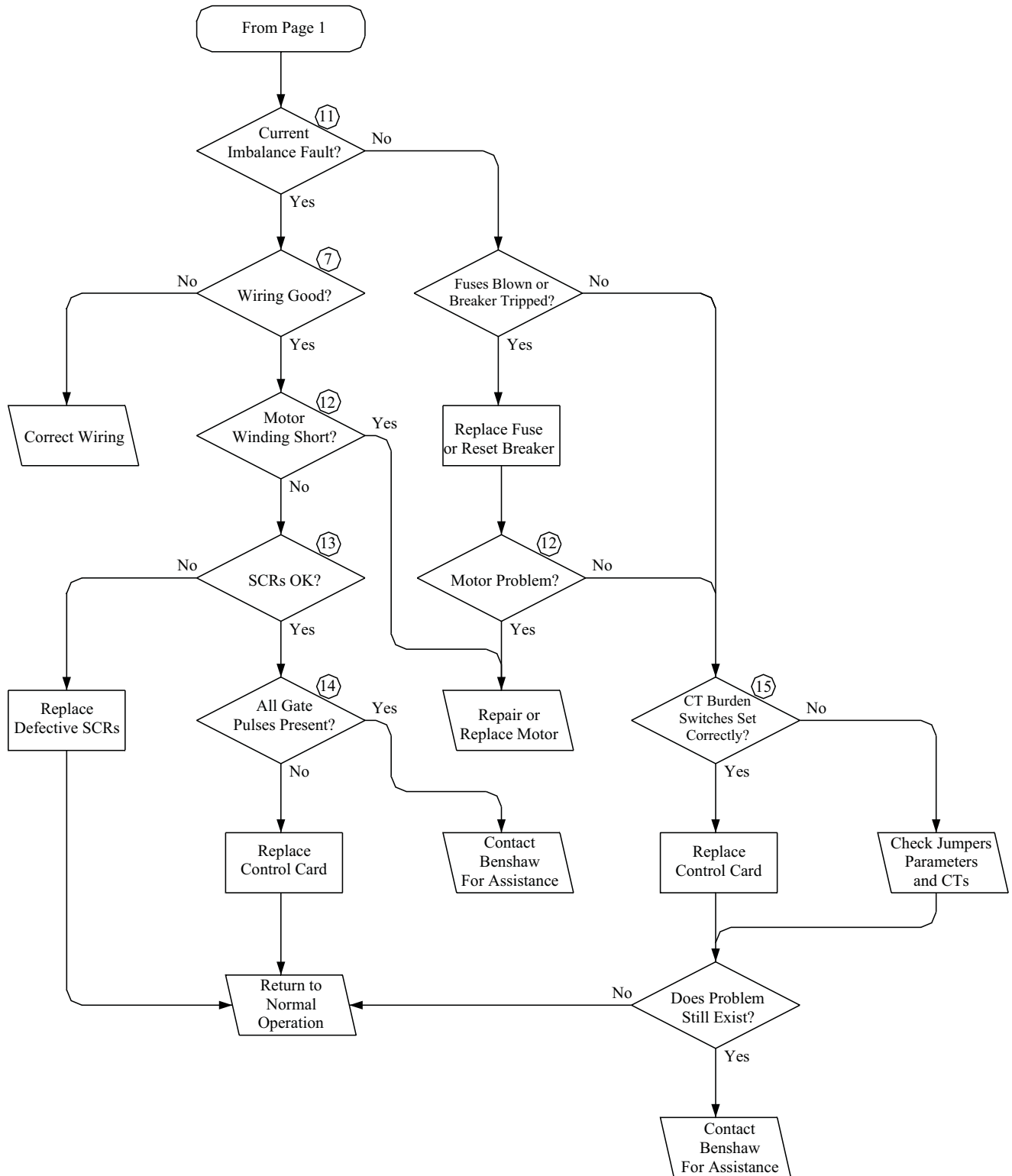
Starter Diagnostics

General Information

The diagnostic flowcharts on the following pages can be used to help locate the source of a problem with an operational motor. The numbered steps on the flowcharts correspond to notes on the page after the flowcharts.



5. OPERATING PROCEDURES



5. OPERATING PROCEDURES

Flowchart Details:

1. **Fuses** Determine if power line fuses have been installed, and if they are operating properly.
2. **Circuit Breaker** Determine if the circuit breaker is off, or if it has tripped and disconnected the line from the starter.
3. **Power Line Voltage** Verify that line voltage is present, and is the correct voltage.
4. **Phase Order Fault** If Fault Codes F1 or F2 are displayed on the control card LED display, exchange any two incoming power line cable connections.
5. **Heat sink Switch** Investigate whether a heat sink thermal switch contact is open.
6. **Safety Device** Determine if a safety device attached to the starter is disabling the start command.
7. **Wiring Connections** Verify that the wiring connections are correct and the terminations are tighten.
8. **Air Temperature** Investigate whether the air temperature surrounding the heat sink is too hot.
9. **Air Circulation** Determine if the air flow around the heat sink fins is being restricted, or if a fan has failed.
10. **Motor Overload** Determine if the motor's load is too large for the motor size.
11. **Current Imbalance Fault** If Fault Codes F23 or F24 are displayed on the control card LED display, diagnose and correct the cause of the current imbalance, or adjust the current imbalance parameter P16 (Refer to page 28 for information on adjusting the parameter).
12. **Motor Winding Problem** Conducting a megger test of the motor may identify if the loss of current occurs at the motor.

NOTE: To avoid damaging the starter, disconnect the starter from the motor before conducting the megger test.
13. **SCRs** This step may help determine if a problem exists with the SCRs. Using a multi-meter or similar device, measure the resistance between:
 - L1 terminal and T1 terminal.
 - L2 terminal and T2 terminal.
 - L3 terminal and T3 terminal.The resistance should be more than 50k ohms.

Measure the gate resistance between the white and red of each twisted pair (6 total). The gate resistance should be between 8 and 50 ohms.

CAUTION: Hazardous voltages exist at the starter terminals. **LOCK OUT ALL OF THE SOURCES OF STARTER POWER** before measuring the resistance.
14. **Gate Pulses** This step may help determine if the control card is operating correctly. Check for a gate firing voltage between 0.3 and 1.5 volts when the card is operating.
15. **Motor Current** Determine if the motor current signal scaling is correct (Refer to page 16 for information on motor current signal scaling).

5. OPERATING PROCEDURES

5.7

Default Settings

General Information

As a programming convenience, the operating parameters can be reset to their default values at any time.

If fault code F29 appears on the LED display on the control card, the previously programmed operating parameters have been deleted.

If the majority of actual operating parameter settings were the default settings from when the starter was manufactured, then the parameters can be automatically reset to their default values using the reset default settings procedure.

NOTE: Any of the operating parameter settings that were customer specified must be manually reprogrammed as detailed in chapter 5 of this manual.

Default Values

The operating parameter default settings are:

Parameter	Description	Default	Programmed
P 1	Motor Full Load Amps	1 Amp	_____
P2	Overload multiplier	1.15	_____
P3	Motor Thermal Overload	Class 10	_____
P4	Initial Motor Starting Current	100%	_____
P5	Max. Motor Starting Current	600%	_____
P6	Motor Ramp Time	15 seconds	_____
P7	Motor Stall Time	30 seconds	_____
P8	Deceleration Level 1	40%	_____
P9	Deceleration Level 2	10%	_____
P 10	Deceleration Time	OFF	_____
P 11	Overcurrent Trip Level	50%	_____
P 12	Overcurrent Trip Time	OFF	_____
P 13	Undercurrent Trip Level	25%	_____
P 14	Undercurrent Trip Time	OFF	_____
P 15	Line Phase Sensitivity	1r5*	_____
P 16	Motor Current Imbalance	20%	_____
P 17	Current Transformer Ratio	288	_____
P 18	Meter Mode	10	_____
P 19	Meter Dwell Time	2 seconds	_____
P20	Passcode	d 15	_____
P2 1	500% Current Kick Time	OFF	_____
P22	Starter Mode	nor	_____

* Single phase power line phase sensitivity (P15) default setting is SPH.

Reset Default Settings

If there is a reason that the user wants to quickly reset the parameters back to the default settings, then the reset default settings procedure can be performed. This will reset all the parameters to the default settings listed above. The reset can also be performed to clear a passcode that has been forgotten.

To automatically reset the operating parameter to the default settings:

Single Phase

While the power to the control card is off:

- Hold the Parameter push button and the Down push button on the control card.

While continuing to hold the Parameter and Down push buttons.

- Restore power to the control card.
- Continue to hold the Parameter and Down push buttons until F3 I appears on the LED display on the control card.

When F3 I appears on the LED display:

- Stop holding the push buttons.
- Remove power from the control card.
- Restore power to the control card.
- Verify that the LED display on the control card displays either:
 - r d H (ready)
 - n o L (no line)

Three Phase

While the power to the control card is off:

- Hold the Parameter push button on the control card.

While continuing to hold the Parameter push button.

- Restore power to the control card.
- Continue to hold the Parameter push button until F3 □ appears on the LED display on the control card.

When F3 □ appears on the LED display:

- Stop holding the push button.
- Remove power from the control card.
- Restore power to the control card.
- Verify that the LED display on the control card displays either:
 - r d H (ready)
 - n o L (no line)

NOTE: If the LED display is blank or anything else is displayed, refer to the troubleshooting section, beginning on page 38.

When either r d H or n o L appears on the LED display, all operating parameter default settings will have been restored. Operating parameters that had been previously adjusted for specific applications must be reprogrammed as detailed in chapter 5 of this manual.

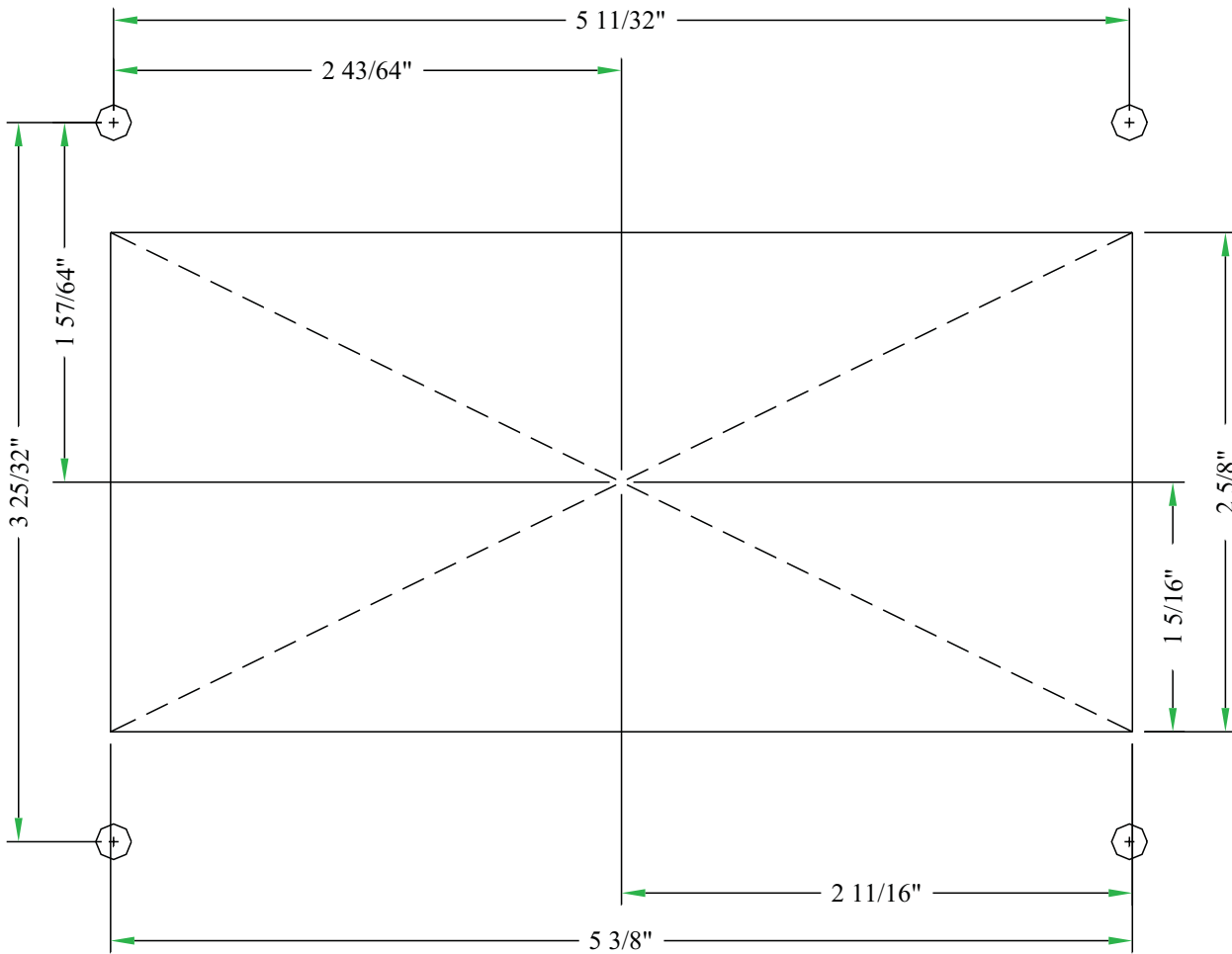
6.1

Door Mounted Display Template

Display Template

This drawing provides detail for the door mounted display cut-out. *Drawing may not print to scale.* The cut-out can be made with a Green Lee knockout punch. The two halves of the required punch are numbered 60075 and 60076.

DMS DISPLAY CUT-OUT TEMPLATE
(ACTUAL SIZE)



HOLE SIZE: Ø 3/16"

7. INSIDE DELTA OPTION

The Benshaw Inside Delta Starter

An example of a soft starter for a 6 lead delta-connected motor is shown in Figure 1, where the power poles of the soft starter are connected in series with the line. The starter draws line current (I_a, I_b, I_c).

An inside delta soft starter is shown in Figure 2, where the power poles are connected in series with the stator windings of a delta connected motor. The starter draws phase current (i_a, i_b, i_c).

In a delta-connected motor, the average phase current is less than the average line current by a factor of 1.73. By comparison of Figures 1 and 2, the most obvious advantage of the inside delta starter is the reduction of current seen by the soft starter. The soft starter current rating is downsized by a factor of 1.73, which is a significant savings in cost and size.

An inside delta soft starter can be considered for motors with more than 6 leads, including 12 lead dual voltage motors. Refer to Figures 3 and 4, which show inside delta soft starter connections for a 12-lead motor. Figures 1 through 4 give the NEMA and IEC nomenclature for motor terminal markings.

There are differences between a line connected soft starter as shown in Figure 1, and the inside delta connected soft starter as shown in Figure 2, which need to be understood. These differences are discussed below.

By observation of Figure 2, access to all six stator-winding terminals is required for an inside delta application. In the line connected soft starter of Figure 1, access to only three leads of the stator windings of the motor is required. For a 12-lead motor, all 12 stator terminals must be accessible.

One failed SCR on any phase of the inside delta soft starter will result in a single-phase condition. A shunt circuit breaker is recommended to protect against this case.

The software for an inside delta application is different than the software for a standard soft starter. The firing of the SCR's is based on the line-to-line voltage crossings. A thirty-degree phase shift in the inside delta application requires an adjustment when Benshaw starts and stops firing the gates of the SCR's.

If a circuit breaker is the only means to disconnect the soft starter and motor from the line, then one leg of the motor leads in the inside delta soft starter is always electrically live when the circuit breaker is closed. This requires caution to ensure these leads of the motor are not exposed to personnel.

7. INSIDE DELTA OPTION

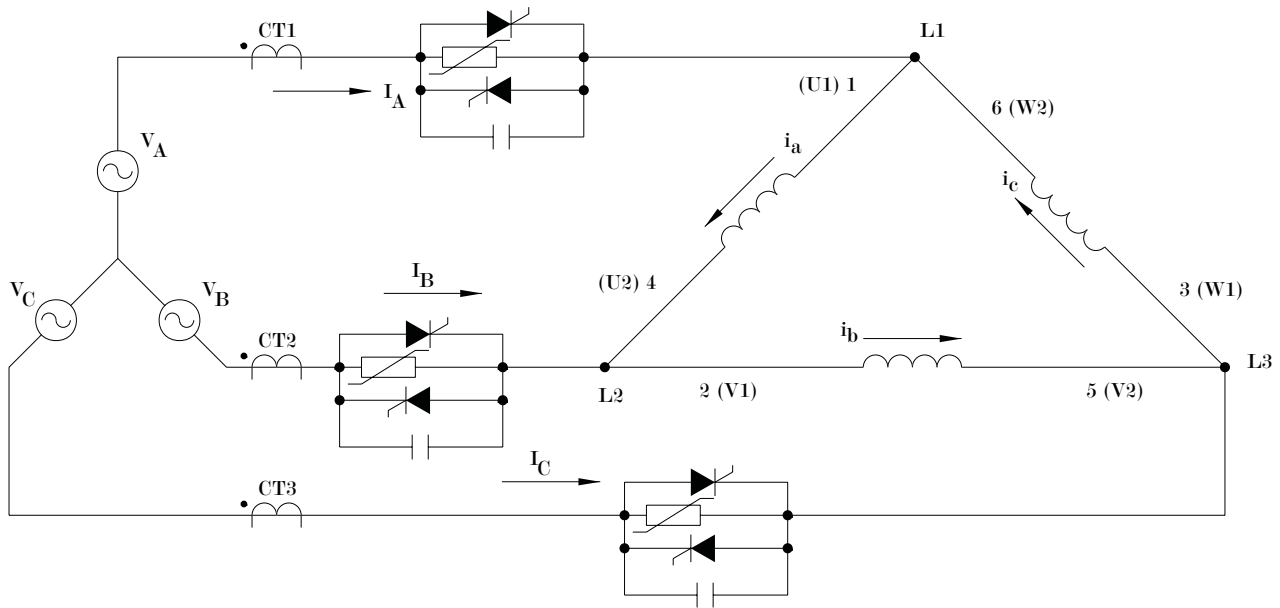


FIGURE 1: EXAMPLE OF A SOFT STARTER FOR A 6 LEAD DELTA CONNECTED MOTOR

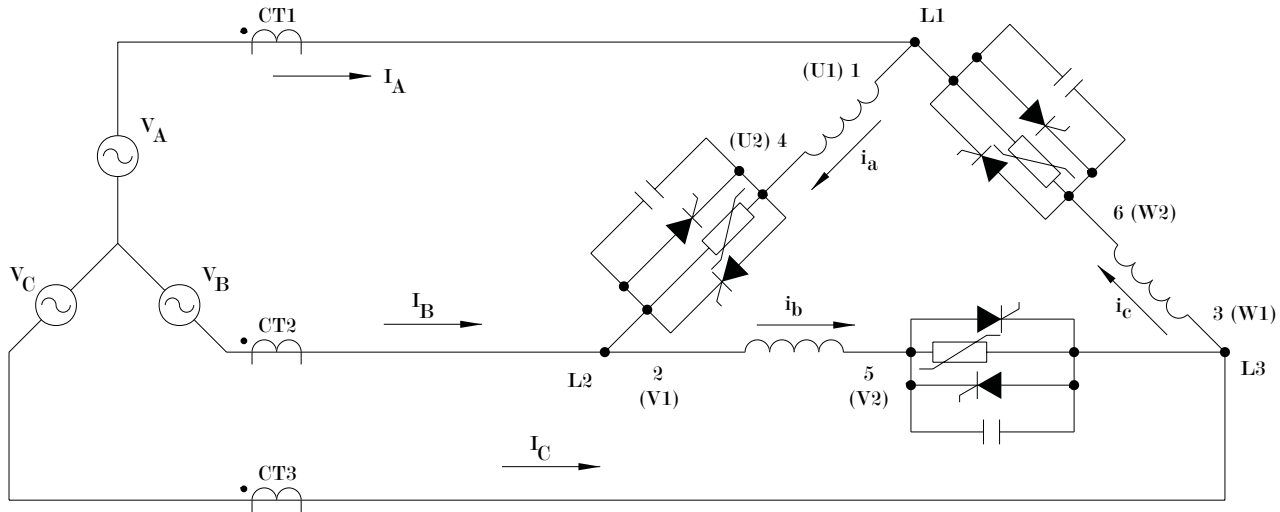


FIGURE 2: INSIDE DELTA SOFT STARTER FOR A 6 LEAD MOTOR.

7. INSIDE DELTA OPTION

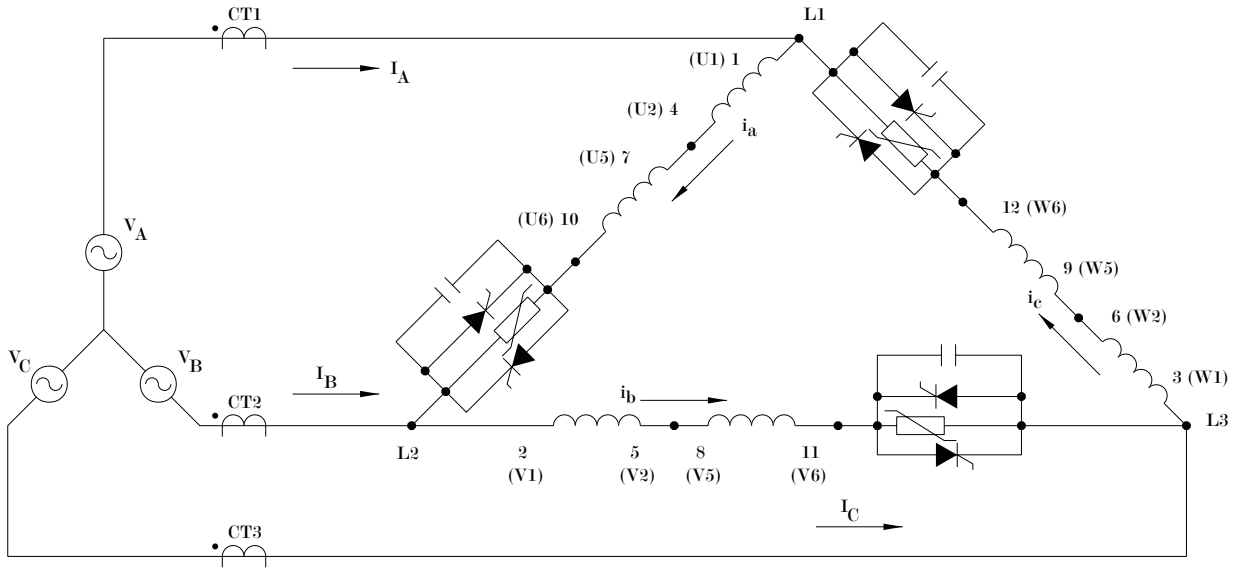


FIGURE 3: INSIDE DELTA SOFT STARTER FOR A 12 LEAD MOTOR (HIGH VOLTAGE).

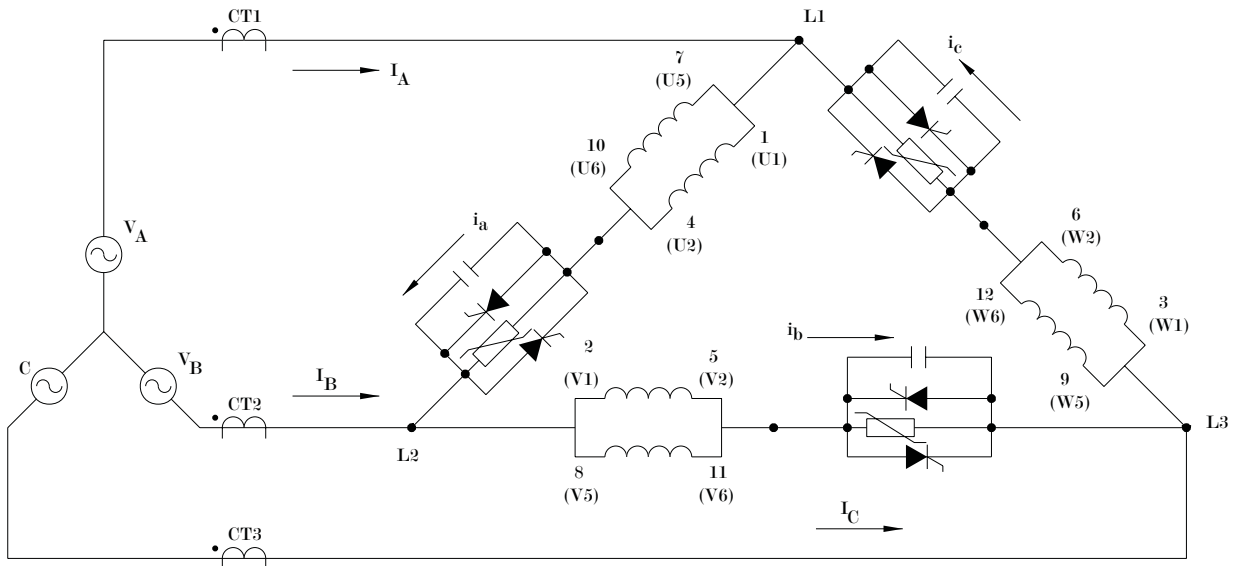


FIGURE 4: INSIDE DELTA SOFT STARTER FOR A 12 LEAD MOTOR (LOW VOLTAGE).

Revision History;

Revision	Date	ECO#
00		
01	Jan. 01/00	
02	Feb. 01/00	
03	Sept. 26/00	
04	Feb. 22, 2001	
05	Mar. 1, 2001	
06	May 28, 2001	
07	July 6, 2001	

Document applies to starters that display a number beginning with 3 (3.x.x displayed) when power is applied.

BENSHAW PRODUCTS

Low Voltage Solid State Reduced Voltage Starters

- ◆ RSD/RSM6 - SSRV Non or Separate Bypass
- ◆ RDB/RMB6 - SSRV Integral Bypass
- ◆ RSM7 - SSRV + DC Injection Braking
- ◆ RSM10 - SSRV + Reversing
- ◆ RSM11 - SSRV + DC Injection Braking + Reversing
- ◆ RSM10/12TS - SSRV Two Speed
- ◆ WRSM6 - SSRV Wound Rotor
- ◆ SMRSM6 - SSRV Synchronous
- ◆ DCB3 - Solid State DC Injection Braking

Medium Voltage Solid State Reduced Voltage Starters

- ◆ 5kV - Induction or Synchronous to 10,000HP
- ◆ 7.2kV - Induction or Synchronous to 10,000HP
- ◆ 15kV - Induction or Synchronous to 60,000HP

Low Voltage - AC Drives

- ◆ Standard Drives to 1000HP
- ◆ Custom Industrial Packaged Drives
- ◆ HVAC Packaged Drives
- ◆ 18 Pulse/IEEE 519 Compliant Drives

RSC Series Contactors

- ◆ SPO/SPE/SPD Motor Protection Relays
- ◆ Enclosed Full Voltage, Wye Delta, Two Speed
Part Winding and Reversing Starters

Custom OEM Controls

Sales and Service

United States

Pittsburgh, Pennsylvania
Dayton, Ohio
Syracuse, New York
Boston, Massachusetts
Wilmington, Delaware
Charlotte, North Carolina
Jacksonville, Florida
Birmingham, Alabama
Los Angeles, California
Detroit, Michigan
Eagan, Minnesota
LaCrosse, Wisconsin
Chicago, Illinois
St. Louis, Missouri
Phoenix, Arizona
Seattle, Washington
Denver, Colorado
Houston, Texas

Canada

Listowel, Ontario
Toronto, Ontario
Montreal, Quebec
Calgary, Alberta

South America

Sao Paulo, Brazil
Santiago, Chile

Singapore

BENSHAW Inc.

1659 East Sutter Road
Glenshaw, PA 15116
Phone: (412) 487-8235
Fax: (412) 487-4201

BENSHAW West

7820 East Evans Drive
Suite 900
Scottsdale, AZ 85260
Phone: (480) 905-0601
Fax: (480) 905-0757

BENSHAW Canada

Wallace Industrial Park
Listowel, Ontario
N4W 3G6
Phone: (519) 291-5112
Fax: (519) 291-2595

Visit us at:

<http://www.benshaw.com>